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THE TECH ENGINEERING NEWS

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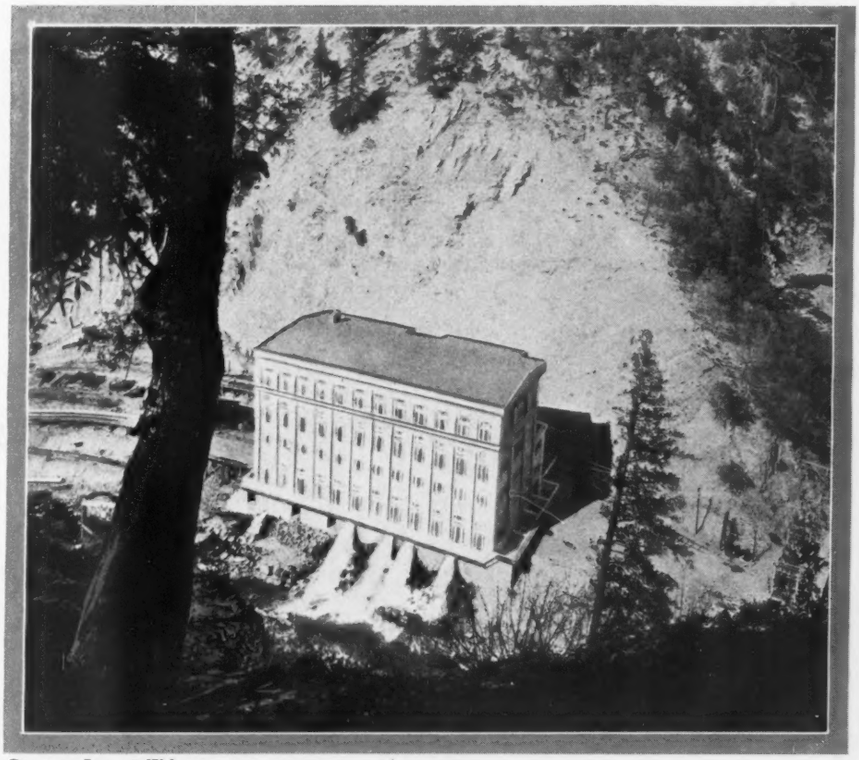
NOVEMBER, 1923



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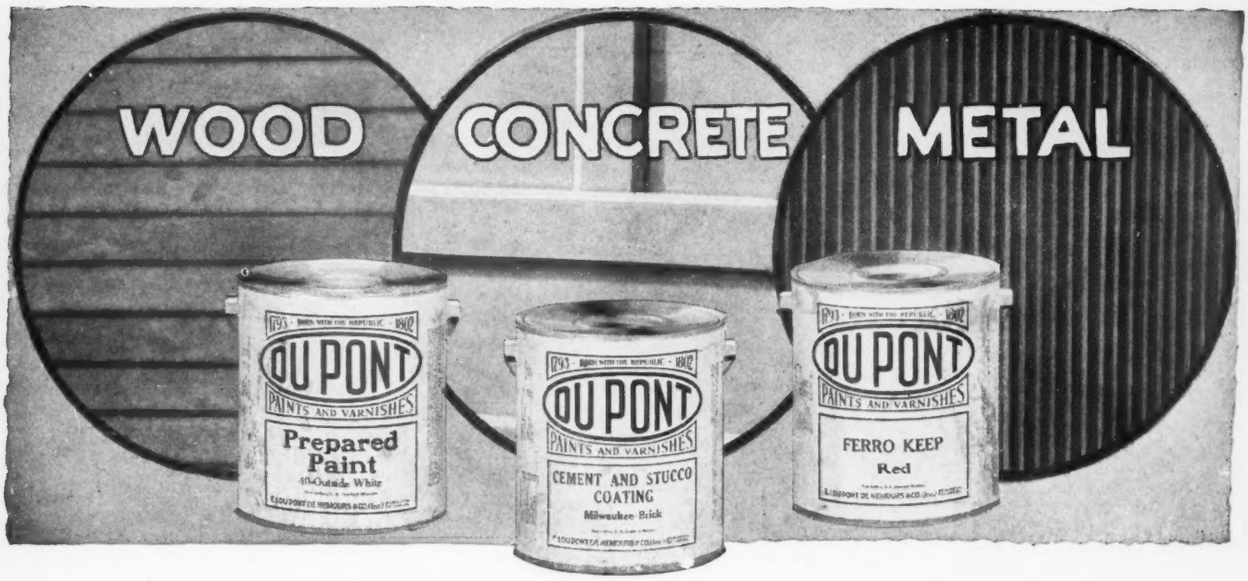

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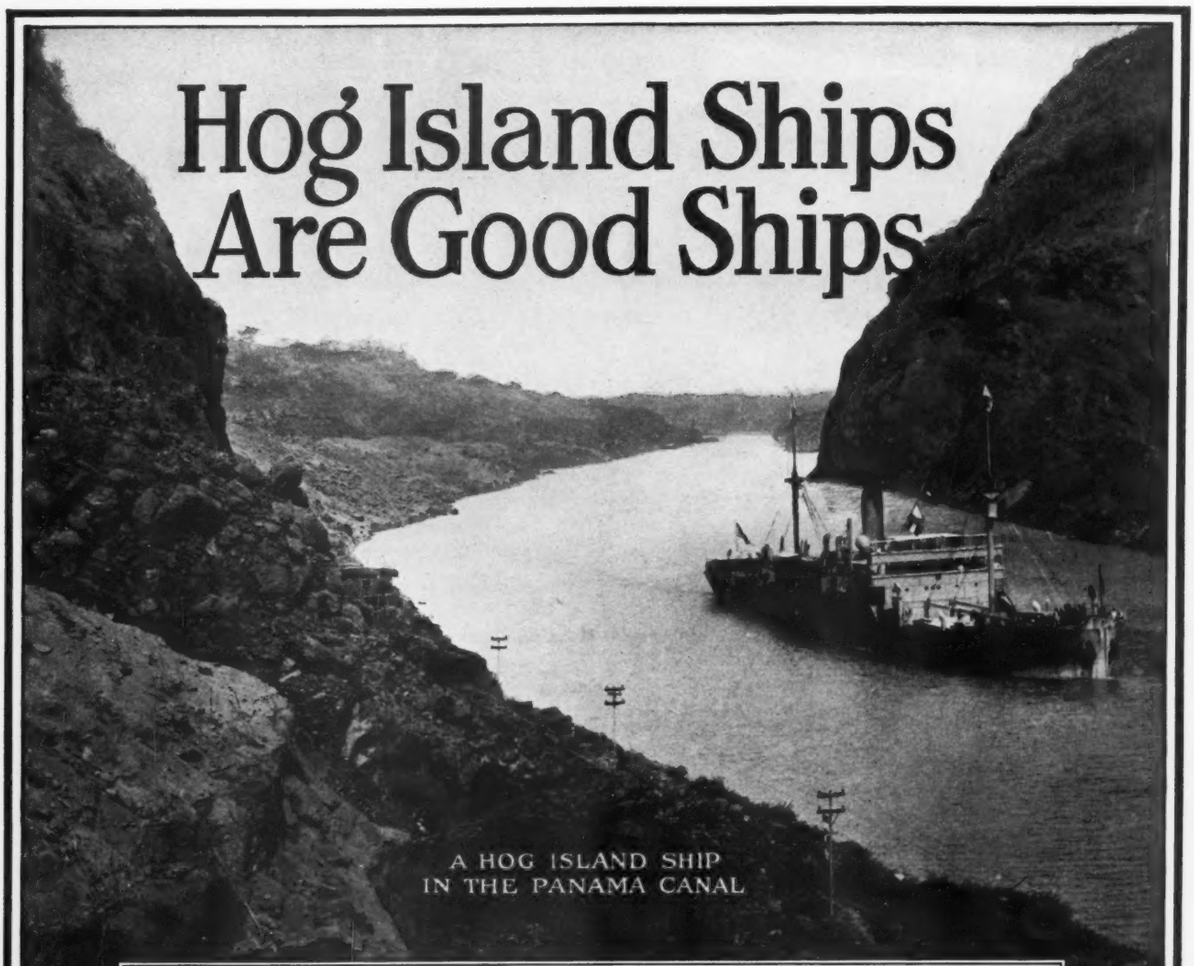

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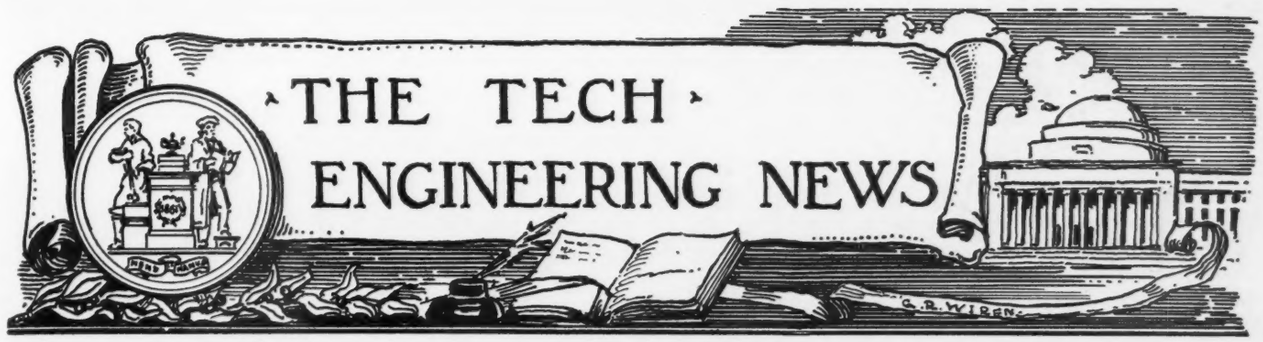

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The Greeks beat us to it!

WHEN you hear one fellow saying of another, *"he's a brick,"* it simply goes to prove that there is nothing new under the sun.

Agesilaus used the same term in praise of his soldiers way back in the days when Sparta was a name to strike fear into the hearts of its enemies.

Why have the modern and ancient world alike used the brick as a symbol of high merit?

Because it is always dependable, resists brutal treatment and never fails to come up to expectations. In other words, it *delivers the goods.*

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE ALUMNI AND UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME IV NOVEMBER, 1923 NUMBER 5

MATHEMATICS

By BASSETT JONES '99

Consulting Engineer; Mayer, Strong & Jones, New York City

PRACTICALLY all the data on which engineering practice is based is of a statistical nature. It is gathered in the field and sorted according to certain more or less arbitrary criteria. In general, such data is not directly deducible from any reasonable and more or less fundamental general ideas as to the actual behavior of the materials of engineering.

Thus while the laws of thermodynamics are deduced from a hypothesis, or from a group of interrelated hypotheses, as to the general nature of gases, there are no gases exactly of this kind. Only in so far as any actual gas is of the kind specified by such hypotheses does it behave according to the mathematical statements, or necessary implications, of the underlying assumptions which the laws of thermodynamics express.

Again, the laws of static structures deduced from hypotheses as to the general behavior of ideal solids subjected to stress and strain fit actual cases only in so far as the materials used in structures are of this ideal nature. The fact that few, if any, solid materials even approximate the ideal, is evidenced by the large "factors of safety" employed, and by the highly empirical nature of the working rules commonly used in design.

The theoretical laws governing the flow of ideal liquids or gases through ideal pipes so little fit with the experimental data that purely empirical rules for the determination of pipe sizes are always used.

Even in the laboratory, only occasionally the available materials can be selected, shaped or composed so that the results of tests are sufficiently in accord with deductions from physical laws that the tests may be said to demonstrate the validity of these laws.

When the student, fresh from the artificial environment of his school, lecture room and laboratories, where physical laws are demonstrated by such highly specialized means and materials, is thrown on his own resources and surrounded by conditions and materials in which variations from physical theories are more conspicuous than concordance with such theories, he frequently finds himself entirely at sea. His studies have left him with an attitude of mind expressed in a belief that the world is a huge example of the application of certain differential equations. But he eventually discovers that in most cases his differential equations constitute but a sorry description of the world's behavior. If he be blessed with peculiar intelligence he may deduce from this that his differential equations are valid only to the degree of approximation that the assumptions on which they are based are valid assumptions as to the actual underlying physical motifs. If he be not so blessed, he will soon learn to look with disdain on mathematical research and will resort to empirical methods which, in most cases, will give him results sufficiently approximating his aim. As a matter of fact this is the mental attitude of most technical men five years subsequent to graduation.

> *"The fact that mathematics furnishes so powerful a method of approximation is a measure of its great importance as an engine of progress. The danger is that, like religions and philosophies and art and motoring, when the going is easy we all drive in the same place and soon form ruts. We become 'practical' men, who as Disraeli said, 'repeat the errors of their forefathers.'"*

The student soon finds that few if any of the differential equations that reasonably express his very practical problems as a practicing engineer can be put into one of those standard forms he has so painfully learned to solve. On the contrary, he finds that nearly all the equations he meets can be solved only by approximations, and well enough, since the material results finally obtained are themselves only approximations. His real problem is to establish the economic and safety criteria that determine what is "good enough."

Of the rational methods of approximation he has learned, if anything, very little. That such methods in themselves constitute the very basis of the scientific method is quite beyond his understanding.

This common difficulty may be illustrated by the fact that the student has been taught geometry from the Euclidian point of view and with not the slightest warning that it is a valid description, not of physical space, but of a purely ideal space of which, and only of which, certain assumptions or hypotheses, known as postulates, hold true. That Euclidian space, in which "straight lines" and "planes" exist, is a workable space because, and only because, such ideal entities are approximated sufficiently close, and within relatively wide limits, by certain corresponding properties of physical space, is a fact entirely outside of the student's crystallized mental structure. Therefore, to him, the truth is incomprehensible. Such a statement as to the nature of geometry may seem quite as unreasonable as the statement that water crystals have a rhombical and not a triangular or hexagonal section.

In other words, the underlying logical basis of mathematics has been left out of the course of instruction. Repeat to the class Russell's humorous, but fundamentally sound, dictum that "mathematics is that science in which we neither know what we are talking about, nor whether what we say is true." The statement will be under-

(Continued on page 178)

FRANCIS AMASA WALKER

By JAMES PHINNEY MUNROE, '82
Secretary of the Corporation

IN the spring of 1876, a professor of political economy in the Sheffield Scientific School was wrestling with his sensitive New England conscience as to whether or not he should accept an invitation to serve as Chief of the Bureau of Awards at the Philadelphia "Centennial," the first international exposition to be held in the United States. Had he decided that this new type of work was unsuitable, that the "Centennial" would be — as many persons believed — a fiasco, or that his duty to Yale University forbade his assuming this outside obligation, there probably would be, today, no Massachusetts Institute of Technology.

Had this Professor Francis Walker taken no official part in the "Centennial," John D. Runkle and John Cummings, at that time president and treasurer, respectively, of the Institute, and active workers in Philadelphia in the summer of 1876, would have had no opportunity to measure his extraordinary executive capacity and doubtless would have turned to someone else, in 1879, when the need for a vigorous young administrator to save the Institute from financial and educational shipwreck was imperative. Of course, they and the founder of the Institute, Professor Rogers, who, with the backing of a self-sacrificing faculty, was keeping the Institute afloat, might have chosen some other president who would have succeeded in preserving the practically bankrupt school; but it would have been almost a miracle if they had found any one else who combined, as Walker did, so many qualities that the Institute at that particular time required.

From the very first the school's career had been stormy. Conceived in the 1850's, it could not take shape and get its "Objects and Plan" before the Massachusetts Legislature until 1860, when men's minds were more intent upon impending war than upon new enterprises in higher education. It certainly would not have been chartered in 1861 had it not been for four things: The Morrill Act which gave a needed impetus to technical education and provided for the projected Boston institution at least a sort of national backing; the active support of the powerful war governor, John A. Andrew; the social prestige, money and tireless devotion of Mrs. Rogers — daughter of the eminent Boston genealogist, James Savage — and, more than all, the leadership of that eminent man of science, that supremely eloquent speaker and writer, that astute and experienced worker with men and committees, William Barton Rogers, who had conceived a "polytechnic institution" in its entirety as early as 1847, and who was determined that this vision of his should take shape in the city of Boston where, he believed (and his faith was later justified), it would find soundest and most enduring support.

THE TECHNOLOGY SERIES

Last year THE TECH ENGINEERING NEWS published a series of articles on the buildings, laboratories and business administration of the New Technology. This series met with such widespread approval among our readers that we are continuing the idea this year. Our new series will be of a slightly different character, dealing with the great personalities and the more human side of the Institute. As our space limits us to only a bare outline of the subject, it is hoped that the new series will serve as an inspiration to further reading along this line. The topics which the series will cover are as follows:

THE FOUNDERS OF THE INSTITUTE ..... October
Prof. H. W. Tyler, Head of the Department of Mathematics.

FRANCIS AMASA WALKER ..... November
J. P. Munroe, Secretary of the Corporation, M. I. T.

RICHARD COCKBURN MACLAURIN ..... December.
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A HISTORY OF THE SOCIETY OF ARTS ..... January
Prof. H. M. Goodwin, Department of Physics.

A HISTORY OF THE DEPARTMENT OF ARCHITECTURE ..... February
Prof. William Emerson, Head of the Department of Architecture.

A HISTORY OF THE DEAN'S OFFICE ..... March
Author to be announced later.

RELATION OF INSTRUCTOR TO STUDENT AT TECHNOLOGY ..... April
Prof. L. M. Passano, Department of Mathematics.

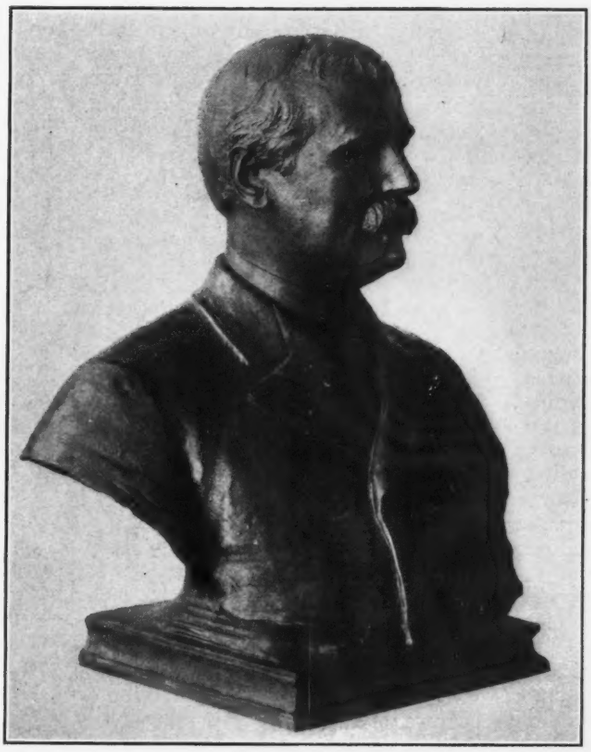
GREAT GATHERINGS AT TECHNOLOGY ..... May
Author to be announced later.

The year subsequent to the granting of the Institute's charter went by, however, with no sign of the one hundred thousand dollars required to make the document effective. A twelve months' extension was allowed; but almost the last hour of that year of grace had expired before a generous gift from Dr. William J. Walker (prophetic name!) of Charlestown, saved the Institute's life. Despite the excitement and general poverty of war times and in the face of rapidly rising costs of building, President Rogers and his devoted group of teachers succeeded in starting the school, in hired rooms, in April, 1865, and in erecting, so that it was soon ready for occupancy, the building on Boylston Street still used by the Institute and affectionately remembered by all, except the very latest graduates, as "old Rogers."

Under a characteristic post-war impetus the Institute grew and, comparatively speaking, flourished; but in 1870, President Rogers' health completely broke down, so that a successor, Doctor Runkle, had to be appointed; in 1873 a far-reaching financial panic swept away many fortunes, great and small; and by 1878 numbers had dwindled, public interest waned, and private benefactions dried up, until there seemed no solution of the Institute's dilemma except to merge it, as had so frequently been urged, with the Lawrence Scientific School of Harvard.

President Rogers and most of his colleagues believed, however, that complete independence was essential to the effective development of the kind of teaching for which Technology stands, and that the Lawrence School, excellent in itself, could not perform for Massachusetts and for the whole United States the measure of educational service which a new institution, untrammeled by ancient traditions, would be able to render. So profoundly did they hold this faith that the faculty themselves proposed a substantial reduction in their already meagre salaries; Mr. Cummings, the then treasurer, gave his personal notes, with practically no hope of recompense, for the most pressing obligations of the institution; the small band of students, past and present, stood by; and Doctor Rogers, dangerously feeble in health, though not so critically ill as in 1870, resumed the presidency, which an alarming illness of Doctor Runkle's had compelled the latter to give up.

Doctor Rogers undertook a burden quite too heavy for an invalid of seventy-four on three conditions: that he should be relieved of the daily details of administration; that the friends of the Institute should save it from bankruptcy by raising what, under the circumstances, was the immense sum of one hundred thousand dollars; and that, as soon as possible, a young and active successor, as president, should be secured. The first condition was easily met; the second required two years of herculean effort; the third seemed almost impossible. What man strong enough to weather a storm that even President Rogers, with all his power and prestige, found difficulty in riding, could be found, when almost nothing existed in the Institute's situation to tempt such a leader? The salary that could be offered—and even that precarious—was only five thousand dollars; the Boston atmosphere, when not actually hostile, was indifferent to a rival of the Lawrence Scientific School; substantially all sources of giving had either been temporarily choked by the panic, or were pledged to Harvard College; the student body at the Institute was dwindling, the faculty were wretchedly underpaid, the corporation, with notable exceptions, had lost the impetus given in the beginning by the enthusiasm of Doctor Rogers, and the pressure towards surrender was greater than any one in these prosperous days of Technology can possibly comprehend. In short, the Institute seemed to be a notable, but unwise, experiment that had proved uncommonly unsuccessful.



Francis A. Walker

Those charged with the responsibility of meeting President Rogers' third condition believed, however, that one man could save the Institute. He was Francis Amasa Walker, then superintendent, for a second time, of the Bureau of the National Census, as well as professor of political economy at Sheffield. General Walker had had no previous association with the Institute and was a "classicist" by training; he was not a "scientist" in the technical sense, though eminent in the sciences of economics and statistics; he was not a particularly good public speaker; and he had neither money of his own nor important connections with generous millionaires. Indeed, he had rather disturbed some of them by his bold upsetting of certain ancient and comfortable economic fallacies. Yet Runkle and Cummings had watched him handle superbly a very difficult situation in the "Centennial" Bureau of Awards; his skillful and absolutely honest administration of the Census of 1870, with promise of even greater things in that of 1880, had shown him to be a rare executive; his long experience in Washington and his extraordinary personal charm promised success with both legislator and prospective donor; while his keen interest in progressive methods of teaching and in the real, all-round education of young men, marked him as peculiarly fitted for the difficult task confronting the Institute's new head. With heaven-sent wisdom, therefore, the authorities literally "pestered" General Walker to take the presidency; and, finally, in a spirit of entire self-sacrifice and because of his profound belief in the future of the school, he accepted the thorny and thankless undertaking.

Born in Boston in 1840, son of the eminent economist and publicist, Amasa Walker, graduated from Amherst at twenty, and an eager volunteer, the very moment that he was twenty-one, in the Civil War, he made a notable record therein, rising from sergeant-major to brigadier-general while assistant-adjutant-general on the staffs of Couch, Warren and Hancock, and being frequently cited for exceptional service. He was at the front in substantially every engagement of the Second Army Corps, was severely wounded at Chancellorsville, and, late in the war, was captured, made a thrilling, though vain, "get away," and was confined for some months in Libby Prison. After a short experience with school-teaching, he determined to enter journalism and went to Washington, as most journalists do, to acquire experience. His capacity was quickly noted; and he was appointed first, chief of the Bureau of Statistics, and then superintendent of the Census of 1870. While still in that office, he was called to the Sheffield Scientific School to teach political economy. Incidentally, he performed a year's notable work in reforming the Bureau of Indian Affairs, served, as already noted, the "Centennial" at Philadelphia, and made far-reaching contributions to political economy through his volumes on "The Wages Question" and "Money."

He had been sought as president by several colleges; but not until the call came from the Institute did he seriously consider this field of public service. And because of his obligations at New Haven, and at Washington as superintendent of the Census of 1880, it was not until the fall of 1881 that he could take up the new duties in Boston. From then until his untimely death in 1897, the record was one of ceaseless and devoted labor on his part, of steady progress on the side of the Institute. To indicate merely the material development of the school in the less than sixteen years of his administration, the number of students increased from three hundred to twelve hundred; the faculty from thirty-eight to one hundred and fifty-six; and the number graduating in 1897 was one hundred and seventy-nine as against twenty-eight in 1881. Meanwhile the buildings and equipment had more than doubled in value, the current income had been increased five times and the endowment thirteen times.

These bald figures give but a faint indication, however, of Walker's service to the Institute. He found it a small, struggling, discouraged school with a reputation scarcely more than local. He left it a powerful and

(Continued on page 186)

SYLPHON TEMPERATURE REGULATORS

By G. M. ELLIS
Fulton Company, Knoxville, Tennessee

IN making a study of Sylphon Temperature Regulators, it would seem appropriate to give first attention to the most important element in their construction. The Fulton Company was the first manufacturer of a self-contained type of temperature regulator to employ an all-metal, seamless diaphragm in the motor chamber. This diaphragm bears the trade name of "Sylphon" and marks the most important development in heating appliances made within the last century. The Sylphon bellows was conceived and developed by Mr. W. M. Fulton, president of the Fulton Company, and more than fifteen years ago was offered to the trade as the first all-metal, seamless bellows.

Everyone is familiar with the Japanese lantern, or the accordion, made of paper, leather, or similar fabric and having deep folds or corrugations extending around its circumference, permitting it to be elongated and compressed through a considerable range of movement in the lengthwise direction. Most engineers are likewise familiar with the aneroid barometer or the barograph, employing a bellows-like structure built up of annular pieces of sheet metal soldered together at their exterior and interior peripheries, giving to this structure a certain amount of lengthwise movement similar to that possessed by the Japanese lantern and accordion. Until the Sylphon bellows was produced, nobody ever heard of a structure of this kind made entirely of metal, absolutely devoid of seams or joints, and not only capable of a large amount of longitudinal extension and compression, but also having the power to resist hydrostatic pressure to a far greater degree than had hitherto been possible in structures of this kind.

The Sylphon bellows being made entirely of metal and free of seams is unaffected by the heat and pressure of steam or the action of water pressure. Its folds, or corrugations, possess great resilience, so that its action is quite similar to that of a highly tempered spring. It can be extended and compressed in a lengthwise direction to a considerable distance without passing beyond the elastic limit of the metal of which it is composed. These resilient walls possess almost incredible strength and durability.

The all-metal, seamless Sylphon bellows used as the motor element makes possible the automatic control of temperature within narrow limits; gives quick response to small temperature changes; furnishes great power for operating valve, with liberal valve opening.

Sylphon Temperature Regulators are of the type commonly known as "self-contained," derived from the fact that the power for operation is generated within the instrument itself. The thermostatic part, or power developing element, of these regulators is partially filled with a volatile liquid, these liquids being selected according to the temperature range over which the instruments are required to operate.

The thermostatic part is composed of the bulb, which is inserted into the liquid or element, the temperature of

NO. 931 SPRING TYPE NO. 932 DETACHABLE TUB TYPE

which is to be controlled; the Sylphon bellows, or motor chamber, previously described; and a hollow flexible tubing which connects the thermo-sensitive bulb with the Sylphon bellows. Within this thermostatic part is placed the volatile liquid heretofore referred to, which furnishes all of the power required in the automatic operation of the regulator.

It is a well-known law of physics that vapor pressures are constant for given temperatures, the increase of the vapor pressure being in direct proportion to the increase of temperature. The power developed is approximately .5 pound for each degree in temperature rise. .5 pound multiplied by degrees temperature rise times the effective area of the diaphragm will give the total force exerted for opening and closing the valve. Sylphon bellows are used with diameters of three and five-eighths, four and five-eighths, five and three-fourths and eight and three-fourths inches, according to the size of the regulator, with mean effective areas of 7 square inches, 12.5 square inches, 21 square inches and 47 square inches respectively.

Having discussed the power element of the regulator, we can now pass to the means for controlling this power so that the regulator will operate at a given temperature. This is accomplished by setting up an opposing force against the Sylphon bellows. In the No. 931 type the Sylphon is opposed by a spring. The spring tension is increased or diminished by rotating a hand wheel on a screw threaded stem so that by turning the hand wheel a greater or less force is exerted against the Sylphon bellows. Rotating the hand wheel upward increases the tension against the Sylphon bellows, thereby raising the operating temperature of the regulator, and rotating the hand wheel downward decreases the tension, thereby lowering the operating temperature.

In the No. 930 type the Sylphon is opposed by a lever and weight. The tension is increased or diminished by moving the weight upon the lever. Moving the weight toward the end of the lever increases the tension against the Sylphon bellows, thereby raising the operating temperature of the regulator, and moving the weight toward the fulcrum diminishes the tension against the Sylphon bellows, thereby lowering the operating temperature of the regulator.

The normal temperature range is 40 degrees. By manipulating the adjusting mechanisms just described, the regulator may be set to control at any desired point within a range of 40 degrees in the Fahrenheit scale. Instruments may be furnished to control temperatures as low as 20 degrees Fahrenheit and as high as 310 degrees Fahrenheit, keeping in mind that a temperature range of 40 degrees for any one instrument between these two extremes is possible.

The valves used are the best double-seated, balanced type and furnished in iron pipe sizes from one-half to eight inches inclusive. In the handling of steam or water under pressures exceeding 30 pounds per square inch a double-seated, balanced valve is necessary, in order that pressure may be equalized on the poppet. Sensitive regulation could not be obtained otherwise. For pressures below 30 pounds per square inch a single-seated valve may be used. On such instruments we use our Sylphon Packless Valve, thereby doing away with all friction in packing gland, and eliminating cost of labor of repacking valves.

(*Continued on page 182*)

THE ALDRED LECTURES

THE first of the Aldred Lectures of the Massachusetts Institute of Technology, established by Mr. J. E. Aldred, who carried to a successful conclusion the immense hydro-electric development at Shawinigan Falls on the St. Maurice River in Canada, is announced for the afternoon of November 9. Mr. Gerard Swope, a Technology graduate of the class of 1895, president of the General Electric Company, will deliver the first of the lectures. Other eminent industrialists and engineers are to complete the program for the first year, which will consist of twelve lectures.

President Stratton has appointed Prof. D. C. Jackson, head of the Department of Electrical Engineering, and Prof. Vannevar Bush, in charge of graduate work in Electrical Engineering, to coöperate with Mr. Aldred in establishing the lectures. A number of prominent men have been invited to give papers in a schedule that is being arranged to cover the next five years. The lecturers, representing all branches of industry, come from all parts of this country, and some from Canada. The twelve lectures which will be given this year will be open only to the faculty, seniors and graduate students of the Institute and a limited number of outsiders, but will probably be published for general distribution next spring.

Many experiences in Mr. Aldred's active career in the industrial world led him to establish this course of lectures. His first work was as an employee in a mill in one of the manufacturing towns of New England. This gave him some light on conditions then common to manufacturing, and he was impressed with the fact that many operations involving technical knowledge were carried out by the so-called "practical men" who had no real knowledge of the principles involved in the various processes they carried out. This led to his taking up the study of chemistry, which he was able to do by working nights under the tuition of a graduate of Tech. It so happened, however, that he had no immediate opportunity of employing the little technical knowledge that he had acquired, as circumstances subsequently diverted him into other channels, and ultimately into the banking business.

Through his banking activities he became interested in the project of developing water power in Canada, and undertook to carry out the development at Shawinigan Falls on the St. Maurice River in the Province of Quebec. This grew into an enterprise of such importance that he eventually gave his entire time to carrying out his plans, which comprehended the development of a hydro-electric plant of one hundred and fifty thousand horse power capacity, the utilization of power locally for industrial purposes, the consequent necessity of the building of a town, and the transmission of electricity to various cities in the Province of Quebec, including Montreal and the city of Quebec. All of these undertakings were finally accomplished, and the company became a great factor in the upbuilding of eastern Canada. Various enterprises grew out of these activities, including the development of paper mills, building of plants for the utilization of electricity in the manufacture of calcium carbide, chemicals, etc. All of this work, involving a great amount of engineering and construction, brought him in contact with men of outstanding ability, graduates of most of the prominent technical schools in Canada and the United States.

His experiences in Canada were practically duplicated when he undertook to complete the development of a power plant in the Susquehanna River at McCall Ferry. As an outgrowth of that enterprise, he became the dominating factor in the Consolidated Gas, Electric Light and Power Company of Baltimore. These enterprises also carried with them contingent interests in the form of industrial operation of a varied character in paper mills, carbide plants, chemical plants, cotton mills, sheet steel manufacturing, brass and copper tube manufacturing, asbestos plants, automobile manufacture.

In his years of varied experience in connection with these operations he found many instances where the engineers made unfortunate mistakes through lack of practical application of their technical knowledge. The sum of his experience brought to him the conviction that the best possible results could only be obtained by a combination of technical training with practical experience and its application. The success which has attended the operations in which he has been involved was not so much the result of any outstanding ability in their organization, but rather the result of a combination of the technical and practical as personified in the men who have been brought together always with these elements in mind.

Mr. Aldred believes that "it will be a contribution to the engineer's training if the proposed lectures give the student an opportunity of coming in contact with men who have made an outstanding success in their various lines of undertaking, and who best illustrate the value of practical experience, coupled with technical knowledge. This contribution is put forward with the hope that it will assist the graduate student going out to take up his life's work by his having in mind at the outset of his career that the work he is to do must be a practical contribution to the problems of the day."

The need of such lectures by men who are responsible for the progress of science and industry has been felt for some time. The professional societies at Technology have carried the idea out in a small way by inviting prominent men to deliver papers at meetings of the societies. Once or twice a year a convocation has been declared for men who have had a message to bring to the students, but up to this time there has been no organized effort to present men representing the various branches of industry in a regular lecture course. Very few students know what line of work they would like to follow and they are usually indefinite as to the practical requirements of an engineer, or of the opportunities of the engineering profession. Technology gives an intensive and extensive course of training, but the average Tech man does not really find himself until some years after graduation due to a lack of appreciation of what has been done and what is being done by men outside his collegiate sphere. While he is at Technology he is so absorbed in the pursuit of technical knowledge and in meeting the requirements of the school that he does not have the time or the opportunity to talk with men on the outside about what is expected of him. Mr. Aldred's plan will help to bridge the gap which exists between the young Tech graduate and his professional work.

The Aldred Lectures together with a short biography of the men presenting them will appear in the Tech Engineering News each month.

Japanese Silk Imports. Japanese exports of silk textiles for the first half of 1923 were 14,851,000 yen, while for the corresponding period of 1922 they were 25,518,000 yen. These figures are for habutai. The export of other silk textiles increased in this period from 16,607,000 yen in 1922 to 21,656,000 yen in 1923.

PORT NEWARK TERMINAL DEVELOPMENT

By JAMES W. COSTELLO
Chief Engineer; Department of Streets and Public Improvements, Newark, N. J.

PERHAPS few cities on the Atlantic seaboard are situated as well, in respect to advantages for port development, as Newark, N. J., a city of industry, only nine miles from New York City which is universally known as the greatest seaport.

It is generally conceded that the port of New York is unable to offer docking facilities for handling the increasing tonnage delivered to its terminals by rail and water, and the Port of New York Authority was created to solve the problem of port expansion.

The city of Newark is contributing to the solution in a great measure, offering additional facilities for the handling of imports and exports by utilizing the great expanse of meadowland bordering the west shore of Newark Bay, for a large port development known as Port Newark Terminal. Newark Bay is an estuary six miles in length and two miles wide, connected with New York Harbor by the Kill van Kull, a waterway offering natural deep water for ocean carriers.

This municipality has up to this time acquired approximately four thousand feet of waterfront on the bay, with the riparian rights extending to the United States government bulkhead line which is nearly two thousand and five hundred feet from the original shore line. The property extends westerly from the bay to the Pennsylvania Railroad main line right-of-way, or nearly three miles.

The first step (1914) consisted in developing that part of the project situated on the north side of the city channel and east of the Central Railroad of New Jersey (Newark and Elizabeth Branch), which crosses the project approximately one mile from the shore. A channel two hundred feet wide and twenty feet deep, connecting with the government channel, was dredged to the original shore and thence inshore on the center line of the development, a distance of one thousand and eight hundred feet. This inshore channel was later widened to four hundred feet and extended to the Newark and Elizabeth Branch of the Central Railroad. Channel excavation was effected with hydraulic dredge and the material so removed was pumped ashore for the reclamation of the meadowland. The area between the shore line and the city bulkhead line (located six hundred feet inshore from the government bulkhead line), was enclosed with a timber bulkhead, and the area therein also reclaimed with hydraulic fill to an elevation of eleven feet above mean low water.

Previous to reclamation, the area enclosed by the timber bulkhead was inundated at high water, and the original bottom was of very soft material. To be assured of the stability of the timber bulkheads, a trench was dredged to approximately fifteen feet below mean low water, removing the soft material and refilling the trench with dense clay pumped from the operations in the city channel. The bulkhead was then driven through this artificial bottom and the required stability and lateral support realized.

A marginal dock was constructed from the inshore terminus of the city channel to the city bulkhead line, and necessary improvements were made within the reclaimed area: highways, railroad, city-owned rolling stock, water service, sewage disposal system and other essential features.

This portion of the development was practically completed when our country declared war on Germany and the entire developed area was turned

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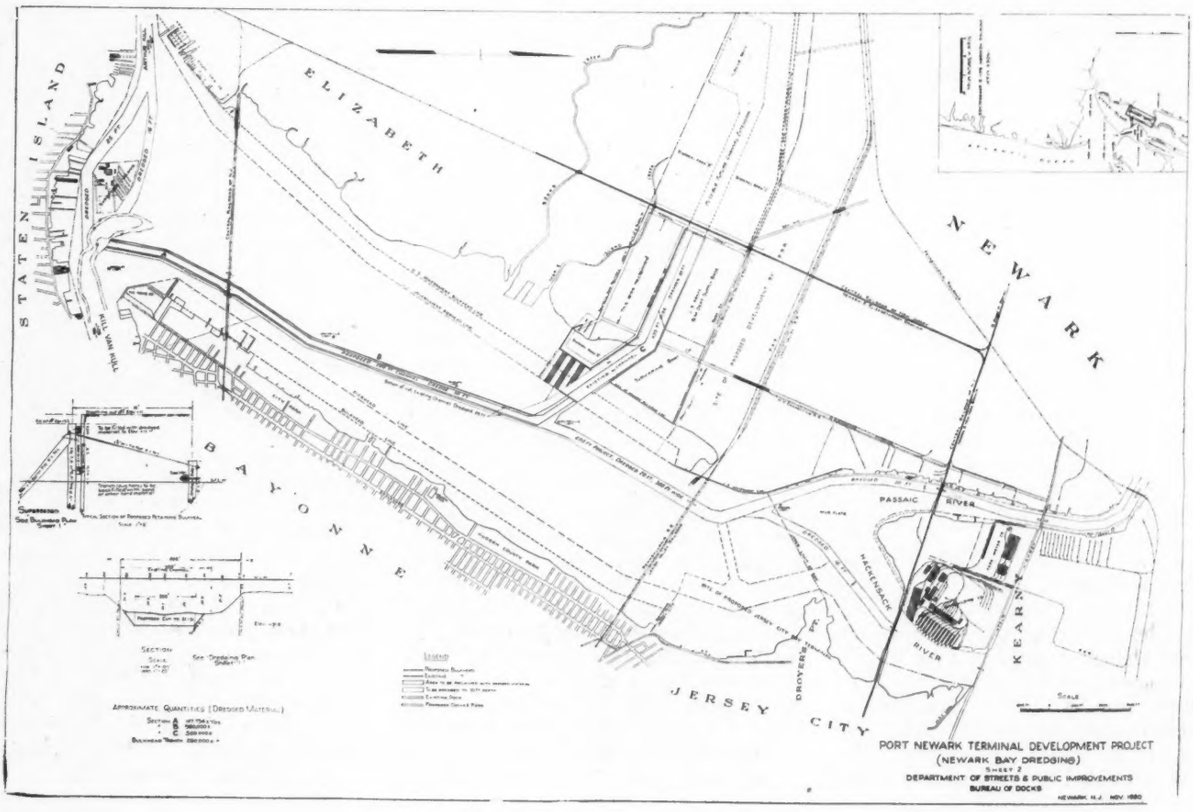

GUNITE IN METAL MINES

By BYRON O. PICKARD
District Mining Engineer, U. S. Bureau of Mines, Washington, D. C.

"GUNITE" is a trade name for a mixture of Portland cement and sand applied under air pressure to surfaces with a mechanical device called a "cement gun." It is also called guncrete. Technically, gunite is a cement plaster applied pneumatically. It differs from concrete in that water is added to the cement and sand during application. Combined with the tamping action of the sand and gravel, this method gives the resultant mixture a greater density than that of concrete. Another desirable quality is that it makes excellent adhesion to rock, brick, tile, concrete, and other surfaces used in construction.

The "cement gun" is a pneumatically operated machine consisting of four main parts — the receiving chamber, the feed wheel, the air motor and the discharge hose and nozzle. At the nozzle the water is introduced through the walls in needle jets under higher pressure than the air pressure used in the gun, "thereby causing these jets to puncture the stream of flowing material." The action of the air in the material hose atomizes the water, thus insuring the wetting of all particles in the sand-cement mixture.

The first important paper on gunite was that read by G. L. Prentiss at the seventh annual convention of the National Association of Cement Users held in New York in December of 1910. At this meeting George S. Rice first saw the use of the cement gun. In a paper written shortly after, he speaks of the great possibilities of the cement gun for use in mines. Gunite was first applied in mines at the Bureau of Mines experimental mine near Pittsburgh, Pa., in 1913, where the walls of the passageways were lined. The results of these tests aroused so much interest that four companies, *viz.*, the Plymouth Consolidated Gold Mines, Ltd., the United Comstock Gold Mines Company, the North Star Mines and the Empire Mines agreed to coöperate with the Bureau of Mines to carry out some experiments under actual working conditions. Certain tests were also undertaken at the University of California.

The slab tests at the University of California indicate that Portland-cement-gunite will stand up in a hot fire. The guniting of timbers will prevent the starting of a mine fire in, or the spread of flames through, the gunited section. The magnesium-oxychloride-cement-gunite slabs did not stand up under the fire test. The gunite crumbled to powder and scaled off, permitting the slabs to ignite. It is reasonable to conclude that headframes, shaft collars, shaft timbers, shaft stations, in fact all timbering in permanent underground workings can be effectively fireproofed by gunite coatings. On the surface, transformer houses, assay offices, powder magazines and other buildings can be fireproofed by gunite coatings; or the buildings can be made entirely of reënforced gunite.

A most important question, on which adequate data is not available, is the effect of gunite in retarding the decay of timbers to which the gunite is applied. It is obvious that such information can be obtained only by observation of gunited timber in comparison with exposed timbers under similar conditions, over a period of years. The experiments are being watched carefully, and the final results will be published.

In the *Engineering and Mining Journal* (October 8, 1921), Daniel Harrington reviews his observations of favorable experiments at the North Butte mine. From what has been learned of the density and nonporosity of gunite and its resistance to the absorption of water, it seems reasonable to believe, if sound timbers free from decay are carefully and completely covered with gunite, the gunite coating will protect the timber against the attack of fungus and insects, and thus retard decay.

Two difficult experiments were undertaken to determine the effectiveness of gunite in the prevention of swelling ground, one in the Plymouth main incline shaft, and the second in the United Comstock main haulageway. It was questionable at both places whether the ground crushing was due entirely to swelling, although undoubtedly swelling was the principal cause. Neither of the experiments was complete or satisfactory, as fresh, hard rock surfaces could not be obtained and the timbers had already taken weight, thus adding crushing force to the swelling forces. It was impossible to coat all of the exposed surface, therefore complete sealing was not attained.

From the many successful experiments in both coal and metal mining operations, and from the temporary checking of the swelling ground in the author's experiments, there is reason to believe that if gunite were applied carefully to fresh, unslaked, rock faces, thereby excluding the air and moisture, swelling of the ground might be completely and permanently checked.

The experiment at the Empire mine to prevent the slabbing of ground was successful. The timbers that originally supported the ground have been removed and the ground is standing well after five months. The experiment by the Calumet and Hecla Mining Company was reported to be successful in controlling slabbing ground. From these experiments, we believe that gunite will be found effective in the prevention of slabbing ground.

Gunite can be used effectively in building temporary and permanent bulkheads or brattices to control underground fires. This is one of the chief uses of gunite in the Anaconda mines at Butte. The experiment of using gunite for permanent bulkheads for fire doors was a decided success. The buttresses can be built quickly and conveniently and in addition the timbers in the immediate vicinity can be fireproofed.

The North Star experiment proved that gunite applied to tight rock formations and concrete dams reduces leakage of compressed air. It is believed that, if dams are made entirely of gunite, or if the concrete dam is coated with three-fourths to one inch of rich reënforced gunite (mixture two and one-half to one, reënforced with one inch poultry netting) and if cracks, fissures, and water courses in the rock wall are sealed with gunite, leakage from ninety to one hundred and twenty pounds air pressure will be reduced to minimum.

Gunite after setting and drying gradually takes on the appearance of neat cement. The degree of whiteness varies with the amount of cement used. By using an ordinary three to one mixture underground, the gunite turns to a light gray color in about three weeks, thus increasing markedly the brightness of the station or haulageway. At the Lawson some experimenting was done by adding ten per cent hydrated lime to the dry mixture, which intensified the whiteness without apparent deleterious effect. If gunite is used at stations or in shafts, the addition of hydrated lime can be safely recommended for increasing the lighting effect.

Guniting smooths the surface, hence there is less resistance to the air current in gunited passageways than in rough rock or in rough timbered openings, and it is possible to pass larger volumes of air. By bratticing off abandoned or burned areas with gunite, it is possible

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ADMISSION GOVERNING FOR GAS ENGINES

By MAJOR F. JOHNSTONE-TAYLOR
British Army

FOR some considerable time after the recognition of the gas engine, that is, the four stroke single acting type, as a reliable prime mover, the so called hit and miss system of governing was the recognized one. It was certainly simple and without doubt effective, and for small engines not requiring very close speed regulation it had everything to recommend it on the score of simplicity and cheapness of construction. The advent of larger powers however, single cylinder engines being now built up to two hundred horse-power, and the necessity for close speed regulation in connection with the direct driving of dynamos, and frequently alternators in parallel, has rendered this somewhat crude arrangement out of date. Most engineers the world over will admit the excellence of the British gas engine, and some details of the Variable Admission governing system, now so much in favour with designers of the best engines, will no doubt be of interest. The principle of variable admission permits of the quantity of the *mixture* being controlled, as opposed to those systems which vary the quality or strength of the mixture by reducing the gas supply or rendering the mixture inert by completely cutting out the gas as the hit and miss system does.

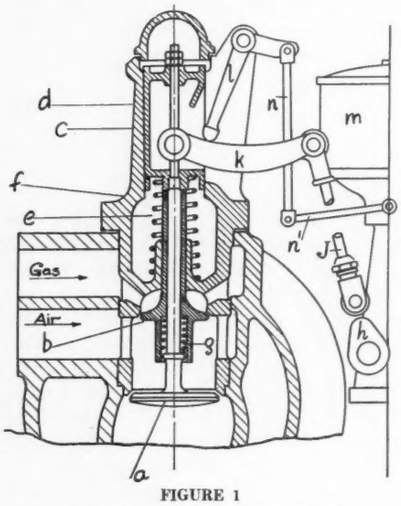


FIGURE 1
ARRANGEMENT AS USED ON THE CROSSLEY ENGINES

In the last named the engine would gather up speed to a point where the governor, by cutting out the gas, would cause a firing stroke to be missed, and if the governor was not very sensitive possibly two firing strokes would be missed. Then the speed will drop more or less rapidly, according to the inertia stored in the flywheel, and in some engines it is quite possible to visually observe the speed fluctuation.

Such conditions are, of course, quite unsuitable to modern electric practice. Throttling the gas supply in place of cutting it off is, of course, an obvious solution of the problem and has been applied by several designers. It cannot be said to be an unqualified success. While it gives a practically constant compression pressure it gives or should give a varying explosion pressure, the variation following the load. If the mixture gets unduly weakened it may fail to ignite, with the result that a firing stroke is missed and the same conditions that appertained to the hit and miss system are apparent, and may be even worse by the following explosion being abnormally violent.

With a variable admission system properly designed there is always an explosive charge in the cylinder at the commencement of the firing stroke. The strength of the charge is not under the control of the governor, it is regulated by the engine attendant to suit the quality of gas coming through. At light loads the charge is smaller, the compression pressure lower and the explosion pressure lower. In fact, the arrangement is much like the cut-off of the steam engine, only in place of the valve closing earlier, the lift and consequently the opening thereof is varied.

The system is now recognized by British designers as being the simplest and most efficient means arrived at for the close governing of four-stroke single-acting gas engines and the fact that it is employed by the leading builders is sufficient evidence of its superiority.

The Tangye, Crossley and Fielding engines may be looked upon as representative of the leading British designs employing variable admission governing. The two former types have a very similar arrangement, but the last named differs therefrom.

The arrangement as used on the Crossley engines is shown in figure one. The air valve *a* and the gas valve *b* are mounted on a common stem on the top of which is a small guide piston *c* working in a cylindrical portion *d* of the valve cage *f*. The valve spring is shown as *e*. The whole gear is contained in a removable cage *f* (of which *d* is a portion). It will be observed that the gas valve is flexibly attached to the air valve and the adjusting arrangement permits of the former opening an amount which is independent of the latter. It has a small spring at *g*. Presuming this adjustment is made, the motion of cam *h* through push rod *j* and lever *k* depresses and opens the valves. The important detail of the arrangement, however, is the fulcrum *l*. In the position shown, *l* is only permitting a small opening of the valves for a light load. The governor *m* through levers *n* and n^1 will, as the load increases, move *l* to a position nearer the vertical, giving *k* a greater leverage and consequently an increased lift to the valve *e*. Not only does this arrangement allow of a most minute variation in the quantity of the mixture admitted, but the position of the fulcrum *l* is an immediate, visable, indication of the load on the engine.

The Tangye Gear is shown in figure two. Here again the gas valve *a* is flexibly attached to air valve *b*, and the cage *c* in which they are mounted is removable bodily from the combustion head. The main valve stem *d* and push rod *e* are connected by link *f*. If there were no resistance to *f* in the shape of a fulcrum, obviously the up and down motion of *e* would simply rock *f* about its pin *g*. The introduction of link *h* causes *e* to depress *d*, but the amount which it does so is dependent upon what position *h* takes relative to it. In the Crossley gear it will be recollected that the varying position of the fulcrum is effected by a swinging motion.

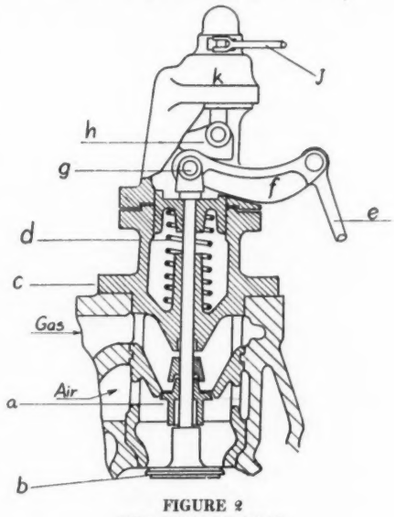


FIGURE 2
THE TANGYE GEAR

In the Tangye gear under review it is a vertical motion and this vertical motion is given by the governor through rod *j* and the quick threaded screw enclosed in hood *k*.

A SUPERPOWER SYSTEM BETWEEN BOSTON AND WASHINGTON

By W. B. WEST
Design Department, Alabama Power Company, Birmingham, Alabama

IN December, 1918, Mr. E. G. Buckland, president of the New York, New Haven & Hartford Railroad Company, at the instance of Mr. W. S. Murray, a consulting engineer of New York City, urged upon the Secretary of the Interior, then Hon. Franklin K. Lane, a survey of the sources of energy in New England and on the Atlantic seaboard as far south as Washington, D. C.

Secretary Lane responded that general and local studies of the country's available power had been pushed with vigor by the Geological Survey as a war measure and that the continuation of this work was already planned under a special appropriation asked from Congress. But, as the plans as Mr. Buckland suggested were of a scale larger and more important than those contemplated, the Secretary of the Interior invited a conference and asked for advice because he at once saw the advantage of making this intensive analysis and of working out a plan to provide for the ever growing energy requirements of this all-important industrial region.

The director of the United States Geological Survey was heard on the proposal on January 30, 1919, before the Appropriation Committee of the House of Representatives. The proposal excited interest but lacked wide enough support, and the committee failed to report the item for further consideration by Congress.

During 1919 the subject of power conservation was most fully discussed before engineering societies and trade as well as commercial bodies and the technical and financial journals paid particular attention to that subject, so the appropriation item was better received at the next session of Congress. Mr. Murray presented the plan to some engineers in New York in 1920.

Mr. Murray was foremost in winning the professional support for the idea, and the strongest presentation of the subject to the House Committee on Appropriations was made by a committee appointed by the Engineering Council, a body of eminent engineers, and Mr. W. S. Murray was chairman. L. P. Breckenridge, of Yale University, and D. C. Jackson of Massachusetts Institute of Technology also served.

An appropriation of $125,000 was carried in the Sundry Civil Appropriation Act for the fiscal year of 1921. It authorized the investigation in the following language: "For the survey of power production and distribution in the United States, . . . and the special investigation of the possible economy of fuel, labor and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries and the preparation of a report, $125,000."

The primary idea of the super-power plan is to construct long, high voltage transmission lines along our Atlantic seaboard so engineers can exchange power in case of emergency or demand, much the same as bankers now exchange money and as railroads exchange coal cars. Progress is largely based upon the relative ability to exchange.

The exchange may involve money, it may involve power, coal cars, or any other useful article of exchangeable value. A great fix we would be in if every small bank in the country was entirely dependent upon its own resources, and could not exchange. Such a situation often precedes what we know as a "panic." Sometimes, in case of a coal shortage, a power plant will be in the same fix as a bank just before such a panic. That is, if they cannot get coal, the power plant cannot "pay out" commercial power.

The super-power system would form a connecting link between the large power plants between Boston and Washington. Furthermore, small power plants, in many cases, would be supplanted by the super-power lines. Hydroelectric energy can now be dependably transmitted four hundred miles with a total loss not exceeding fourteen per cent. A primary need all over the country is the elimination of waste. One of our most repugnant and unnecessary wastes

(*Continued on page 184*)

TRANSMISSION SYSTEM FOR THE SUPERPOWER SYSTEM

MONTHLY NEWS

Preventing Blasting Accidents with the Geophone. The sensitive sound-ranging instrument known as the geophone, which helped in stopping the underground mining operations of the Germans during the war, is now serving those who use explosives for purposes of peace. The geophone is entirely mechanical. With the geophone, sounds so faint that the listener has the sensation of feeling, rather than hearing them, can be detected and accurately identified.

The geophone is essentially a small seismograph. It was invented by the French during the war and was developed by the United States engineers. Across the top and bottom of an iron ring are placed two metal diaphragms. Between these a lead weight, which is fastened to the diaphragms by a single bolt, is suspended. There are also a brass cap-piece and a bottom-plate, which are bolted to the iron ring with the same bolts that hold the diaphragms in place. The cap-piece is provided with an opening over which may be drawn a rubber tube that leads to an ordinary stethescopic earpiece. The case of the instrument vibrates with the earth. The heavy lead weight, suspended between elastic diaphragms, remains, because of its inertia, practically motionless. The air vibration is carried through the tube to the operator's ear.

Generally two geophones are used, one for each ear. This means that if the instruments are placed upon the ground about three feet apart we have the same effect that would be produced if we could place both ears upon the ground at the same time. In other words, the sounds will then appear louder in the instrument nearer the sound source and the direction of the sound can be determined by shifting the instruments about until a position is found where the sound has the same intensity in both ears.

In the quiet of the mine, sledge pounding has been heard by the geophone through about 3,000 feet of solid rock; talking has been detected through about 125 feet of solid coal; through the ordinary fifty-foot coal pillar talking is reproduced about as clearly as by the old-time wax phonograph cylinder. The pitch of the sounds is so perfect that songs are easily recognized through a considerable thickness of coal, but the enunciation is rather indistinct. It can be seen at once that an instrument as sensitive as the geophone might be used in a number of ways to prevent accidents in blasting. — *The Explosives Engineer.*

Conserving Fish by Electricity. A novel use to which electricity has been recently put is the Burkey electrical fish-stop, operated at Wahtoke Lake by the California Fish and Game Commission.

LISTENING WITH THE GEOPHONE

This apparatus consists of a double row of iron bars inserted in the bed of the 90-foot irrigation canal, at distances of 24 inches apart, and charged with 110-volt electric current which passes through the water.

The object of this fish-stop is to prevent the trout, bass and other game fish which are native to the Kings River, out of which the canal flows, from drifting down the ditch to be washed out on land where they die when the water recedes. It is said that the game fish come down the river tail first. The current of electricity causes the fish to remain upstream out of the charged area. The non-game fish come through the barrier head first, and are stunned by the electricity.

This installation prevents the needless killing of game fish in this canal and greatly lessens the number of non-game fish which infest the river at this point. — *Journal of Electricity.*

Bureau of Standards Explosion Due to Leak. The committee appointed by Dr. Burgess at Mr. Hoover's request to investigate the cause of the explosion and fire in the Dynamometer Laboratory of the Bureau of Standards on September 20, 1923 made a detailed examination of the scene of the explosion, received statements from all available witnesses, and, after consideration of all the evidence, presented the following report:

The explosion was caused by the ignition of a mixture of gasoline vapor and air in the altitude chamber. The Board believes that the presence of the gasoline vapor in the chamber was due either to a leak in the feed line leading to the carburetor of the engine or to a leak from the carburetor due to the sticking of the float mechanism. This conclusion is supported by a remark made by one of the members of the testing staff an instant before the explosion, to the effect that the gasoline readings which he was taking indicated the presence of a leak.

The condition of the set-up following the fire is such that it is not possible to establish which one of the above causes occasioned the leak. Since it is known that only three gallons of gasoline had been drawn for the test, that the engine had been running from about 11 a.m. to 12 m. with the chamber open, that the chamber was closed at about 12.30 for the purpose of running at a lower temperature, and that the engine had been operated from about 1 to 2 p.m. with the chamber closed, it is believed that not more than a quart of gasoline could have escaped into the chamber. This amount, however, if vaporized, would have been suffi-

cient to account for the energy of the explosion.

The probable source of the ignition was a backfire through the carburetor. Support to this conclusion is given by the statement of one of the survivors that he heard the engine backfire immediately before the explosion.

The explosion threw out of the chamber a closed apparatus containing about ten gallons of heavy lubricating oil and about five gallons of toluol, breaking the pipe connections and thus releasing part of the contents, which furnished additional fuel for the fire which followed. — *Power.*

ZR-1 Model Studied in Massachusetts Institute of Technology Laboratory. The Bureau of Aeronautics of the Navy Department has just permitted public announcement that a study of a celluloid model of the airship ZR-1 by means of photoelastic methods has been carried on during the past ten months in the laboratories of the Massachusetts Institute of Technology. It is believed that these tests will be of distinct value in the design of airships to prevent a repetition of the ZR-2 and Roma disasters.

The model consists of several thousand pieces of celluloid machined precisely to scale and fitted together in a miniature duplicate of the airship. The testing was performed in the photoelastic laboratory of the Department of Physics by Dr. Paul Heymans and T. H. Frost, of the Technology Staff, under the general supervision of Prof. Charles L. Norton, Head of the Department of Physics.

The phenomena of photoelasticity have been known to science for some time, but have been employed only recently to settle troublesome problems of structural design, many of which cannot be mathematically determined. By this method polarized light is passed through the celluloid of the model under different loading conditions, and the stresses appear in rainbow colors. Since celluloid acts structurally, as do metals used in construction, it is possible by varying the loads on the laboratory model, to determine just how the airship itself will act under various conditions.

As Professor Heymans states: "By this photoelastic method we can look into the vast and intricate network of the dirigible and see exactly what is going on when it is laboring. We can see how she is carrying and distributing the load. We have made an analysis of the ZR-1, saying exactly how the stresses are taken up by the members of the frame and the wires. When we hear of new forces which the ship must meet in its ventures overhead we can try them out on the model here at Technology."

The Technology Department of Physics is the only laboratory in this hemisphere equipped to carry on this work.

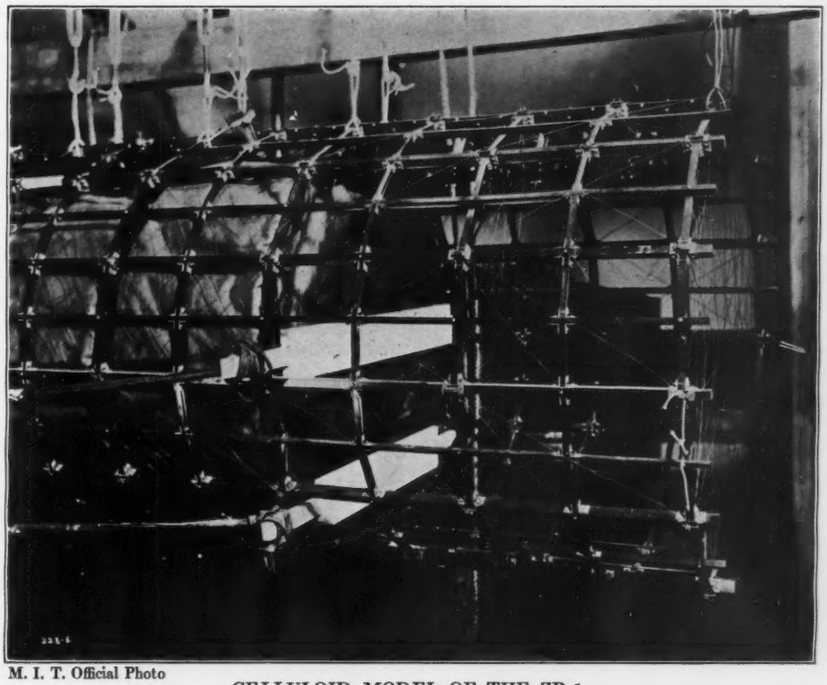
BOOK REVIEW

Chemical Calculations. By R. Harman Ashley, Ph.D. The D. Van Nostrand Company, New York. Cloth, 5 x 7½ inches, 274 pp. and index. 1923, third edition.

The student of chemistry is quite frequently at a loss, when working various problems in the different branches of the science, as to where to find the information necessary to enable him to do his work in the best manner. With the exception of the beginner, all students of chemistry have used several different textbooks for the different branches of the science. As a result, the information dealing with the calculation in hand is often scattered through two or more textbooks, and the student has to laboriously search through these in order to find what he desires. In this book, however, practically all of the basic calculations for the various branches of chemistry are collected under one cover, explained in clear, concise, and thorough language.

It takes up in detail the important types of calculations involved in the study of volumetric, gravimetric, and gas analyses, physical chemistry, and the general rudimentary principles. Although a glance at the first few chapters would convey to the casual reader the idea that the book is too elementary in character to be of much use to one who has had several years of study in this science, a closer examination will show one that these chapters are but an illustration of the author's thoroughness in his effort to produce a book which would cover the subject in its entirety. Numerous sample problems are worked out for every important case, and these with the accompanying explanations, make the theoretical and the stoichiometrical problems with which the student is confronted almost constantly much clearer and easier of solution. In addition to the sample problems, there are included over five hundred problems with the answers given which one may work out in his spare time if he desires to go into the matter further. All of the laws upon which the calculations depend are also stated in order that one may have an understanding of the exact theory of these calculations.

If any one desires to find a reference textbook which will contain the important facts relative to the science of chemical calculations, and obviate the use of numerous and cumbersome books, he will be extremely well satisfied with "Chemical Calculations," not only during his scholastic career, but also in his future work.



M. I. T. Official Photo

CELLULOID MODEL OF THE ZR-1

This model was used in studying the stresses and strains in the structural members

Watch for T. E. N's pictorial section, appearing next month.

THE CONQUEST OF THE CLOTHES MOTH

By VICTOR VAN NESTE, '22
Interstate Chemical Company, Providence, R. I.

TRAVELLING under the formidable name of tineina, the clothes moth has made his way in the world, or rather in our clothes, and holds the flattering record of having conquered all efforts to exterminate him. The battle dates way back to the Old World and has raged furiously up to the present day in every well regulated household, only to see the pest's numbers increase as one's wardrobe expands. Is it destined that "the moth shall eat them up as a garment; and the worm shall consume them as wool" (Isaiah 51:8)? The careful housewife who packs away her shawl in camphor till winter, only to find a box of moth-eaten fragments when the north winds blow again, vows that nothing is safe from the ravages of the seemingly unconquerable foe.

Although the moth is more generally well known as a household pest, the extent of its ravages in the storerooms of woolens is sometimes alarming. Even if only one moth worm gets into a spool of yarn it bores down through, cutting the yarn into short pieces, thus causing the total loss of the product. This sort of damage is frequent in the woolen and yarn business and is the terror of every yarn storeroom.

That it will be possible to overcome the moth plague entirely within a few years, however, is the conviction of those chemists who have been experimenting with the Eulan process, as developed by the Bayer chemists of Germany, after six and one-half years of painstaking experiments. These experiments are both of a chemical and zoölogical character and their success has recently startled the textile and industrial chemistry world. Exhaustive tests carried on by the Interstate Chemical Company of Providence, Rhode Island, have proved the process to render wool and all materials consisting of animal fibers wholly immune to the attack of moths. The most interesting tests made were those in which two pieces of the same material, the one treated by the Eulan process and the other not treated, were placed in the same receptacle stocked with numerous moth worms. Upon inspection several months later the treated specimens proved to be wholly unaffected by the test, while the untreated specimens were reduced to a fragmentary condition. The results of qualitative experiments have disclosed also that the treatment has no effect on the colors of dyed wool, nor on the appearance of the material, and has the advantage of being entirely odorless. None of the valuable properties of the wool are affected by the treatment, and it may be used for furs, carpets, tapestries, and all materials consisting of the keratin common to animal fibres.

Apart from the advantages of the treatment in leaving the wool with its original qualities unaffected, the treatment has the added advantage of being remarkably cheap, as it has been found by the largest mills to add less than three cents per square yard to the cost of the material. Perhaps the deciding factor in the rapidly increasing use of the process in woolen mills of all kinds, however, is its extreme simplicity and the rapidity with which the materials may be put through the treatment. These factors, together with the low cost, will make it comparatively easy for the manufacturers to meet the inevitable demand of the consumer for moth-proof goods when he learns that the chemist has finally solved this age-old problem of rendering animal fibers immune to their attack. How the damage is done by the moth in its evolution from the egg into a winged insect may be interesting if not altogether fascinating.

The winged insect moth seen so frequently fluttering about the room does not eat cloth and itself does no direct damage to the material. It is responsible, however, for any damage done in that it deposits its eggs in the material composed of wool and from these eggs emerge little dull-white worms, or caterpillars, which the entomologist calls larvæ. The larva feeds on the material in which it finds itself until it reaches the state of pupation. At this time, it is about to be changed into a winged insect and in this state it takes no food and is apparently lifeless. Sometime during the period between its emergence from the egg and pupation, depending upon the species, the larva constructs for itself a cocoon out of the material upon which it is living. It never abandons this cocoon until after transformation to the insect, when the perfect moth emerges, leaving its pupal shell within the cocoon. The larva, or worm, therefore, is responsible for the "garment that is moth eaten" and wherever the moth deposits its eggs, there the moth will thrive. Hitherto, the only protection available against damage from these moth worms was that furnished by the numerous repellents used, of which camphor and naphthaline are the most common. The ineffectiveness of these substances has always been a puzzle to those who have found clothes moth-riddled, though they had been packed away with excessive amounts of repellents.

Charles Lester Marlatt of the United States Bureau of Entomology in his report on "The True Clothes Moth" states in regard to camphor, cedar chests, and the like, that "the odors of these repellents are so disagreeable to the parent moths that they are not likely to come to deposit their eggs as long as the odor is strong. As the odor weakens the protection decreases. If the larvæ are already present these odors have no effect on their development. Also if the moths are inclosed with the stored material to be protected by these repellents, so that they cannot escape, they will of necessity deposit their eggs, and the destructive work of the larvæ will be little, if at all, restricted." This seems to be a suitable explanation of why the moth has got in its destructive work so effectively. Frequently the material that is packed away with repellents is already infested with moth eggs. If, on the other hand, the goods are placed in a closed closet stocked with repellents and the parent moth is closed up with them and has no means of escape it will deposit its eggs despite the odor. Add to this the constant decrease in strength of the odors with time, thus minimizing the effect of the repellents, and the fact that where things are packed away with such agencies, the average person is confident that they are immune to attack and it can readily be seen that the use of repellents does more harm than good. The treatment of materials by the Eulan method seems to be so simple that the use of repellents may soon be eliminated.

The actual mechanical work of moth-proofing any material is extremely simple and involves practically only two operations, the thorough impregnation of the wool in a cold water bath of the Eulan solution, and afterwards, when thoroughly dry, the rinsing of it in a bath of clear cold water. That the process of treating the goods is so simple is due to the work which has been done in the laboratory in incorporating in the Eulan, a solvent white powder, all those chemicals which should constitute the moth-proofing solution, so that with the addition of water the necessary chemical changes take place

(*Continued on page 194*)

Most popular college sport

"As I look back on my college days," said the old grad, "it strikes me there were more men playing blind man's buff than all other games combined. I understand this is still the case.

"Get me straight. It was no child's play. What we were groping around for was pretty serious business—nothing less than a career.

"Too many men are in the dark as to what they will do after graduation. Either they neglect to specialize in anything, or hastily select a major which they afterwards regret.

"I know I would be considerably ahead in business if back at college I had sat down for a few hours' earnest thought to find out just what work I liked best—and then gone in for it heart and soul.

"Pick the thing that appeals to you, and don't let them tell you that particular line is overcrowded. Talk this over with graduates you know. Talk it over with your professors. Talk it over with the industrial representatives next Spring. Most of all, talk it over with yourself.

"The main thing is to get on the right track and to keep going. There's no fun in being 'It' in the game of life, with every change in fate ready to push you off an uncertain course."

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Number 32 of a series

EDITORIALS

SUPERPOWER

Like a great many other practical developments of the present time, superpower was, a few years ago, the idle dream of advanced scientists. Its fantastic and far-reaching possibilities appealed to their imagination. Many seemingly insurmountable difficulties stood in the way, however, and the plan was ridiculed by those who styled themselves "practical engineers."

But today, with the perfection of the steam and hydraulic turbo-generating units and the increased efficiency in high voltage transmission of power over long distances, the superpower plan appears practical even to the most "practical." In fact, superpower has a start and is operating successfully on the Pacific Coast, in the Middle West, and some of the Southeastern States. As a result, action is being taken to further the plan and overcome the few still existing difficulties. An example of this tendency is the recent Superpower Conference called at New York City with the approval of the President by Secretary Hoover. At this conference, Mr. Hoover gave a very admirable survey of the whole situation, which is given here in part as follows:

"The reason and need for this discussion is simply that engineering science has brought us to the threshold of a new era in the development of electric power. This era promises great reductions in power cost and wide expansion of its use. Fundamentally, this new stage in progress is due to the perfection of high voltage, longer transmission and more perfect mechanical development in generation of power. We can now undertake the cheaper sources of power from water sources further afield, such as the St. Lawrence, and cheaper generation from coal through larger and more favorably placed generation plants. We can secure great economies in distribution through the interconnection of load between systems, for thus we secure a reduction of the amount of reserve equipment, a better average load factor through pooling the effect of day and seasonal variations together with wider diversification of use by increased industrial consumption. We can assure more security in the power supply from the effect of coal strikes and from transportation interruptions.

All this means the liquidy of power over whole groups of States. At once power distribution spreads across State lines and into diverse legal jurisdictions. We are, therefore, confronted not only with problems of the coördination in the industries of their engineering, financial and ownership problems, but also with new legal problems in state rights and federal relations to power distribution.

This superdevelopment of great areas of cheaper power has been dramatized by those less familiar with the problem, as the construction of great power highways traversing several States into which we should pour great streams at high voltages from great giant water power or central steam stations to be distributed to the public utilities and other large users along the lines of these great power streams. This, indeed, serves perhaps to picture what is meant by superpower development. As a matter of practical fact, however, the natural development of this situation lies first in the interconnection of power supplies between the existing great utility systems, and second, in common action for the erection of large units of production at advantageous points for the mutual supply of two or more of the present systems and in the development of such great water powers as the St. Lawrence. . . .

I do not wish to anticipate the results of the conference but I may point out that the State and National governments are blamed by some persons for this lack of progress. It is said that there is a lack of definite principles and of coördination in the policies of necessary regulation of power utilities by the different States and a lack of coördination and vision in our National Administration of the development of nationally controlled power sources. It is also said that we should not permit the rivalry between our distribution systems and competition for territory to restrict the establishment of interconnection of load and the development of great generation units for their common use.

Whatever the fault may be, it is the purpose of this conference to give preliminary consideration to the problems and principles that might be adopted in interstate relations; to discuss what measures can be devised to assure this needed development and what obstacles in its realization can be removed. . . ."

COLLEGE STUDENTS AND THE RED CROSS

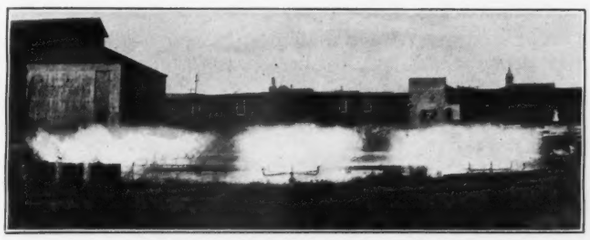
There is probably no word harder worked in the colleges and universities today than "vision." And it is because of this quest of vision that students are thinking with a clarity, a degree of penetration, an inclusiveness, and an earnestness of purpose which did not characterize preceding generations. Underneath a certain surface lightness engendered by the healthful give-and-take of present-day campus life, there is developing a fibre which will stand the test of the epoch upon which the world is entering.

The Red Cross, national and international, recognizes the fact that in the American colleges and universities of today is to be found its leadership for tomorrow, in a work which perhaps more than any other is interpreting to the world at large the full scope and meaning of the ideal of the Brotherhood of Man. Consequently it voices at this time an appeal to the students of America, not only for support in the oncoming American National Red Cross Roll Call, November 11–29, but for serious constructive study of the work and methods of the organization, looking toward the day when they will assume their rightful positions of community, State and national leadership.

The demands of the time are increasingly complex, and the future is heavily charged with forces which as yet defy analysis. It is not by chance that you have come to your high place in life. We believe that it is for a purpose, and that without the best each one can do in service to his fellowmen, all life must be poorer in the end.

"Knowledge we ask not — knowledge Thou hast lent;
But Lord, the will — there lies our bitter need;
Give us to build above a deep intent,
The deed, the deed!"

Spraco Cooling System



In connection with the Municipal Power Plant of the City of Dothan, Alabama, capacity 3,000 gallons per minute.

Note the uniform spray, even distribution and clear air passages. The Superintendent reports that when carrying full load in the hottest days of summer they never obtain less than 27 inches vacuum. In November last they were running with 29.6 inches vacuum. They changed from the old spray system to the new "SPRACO" inside of forty-eight hours.

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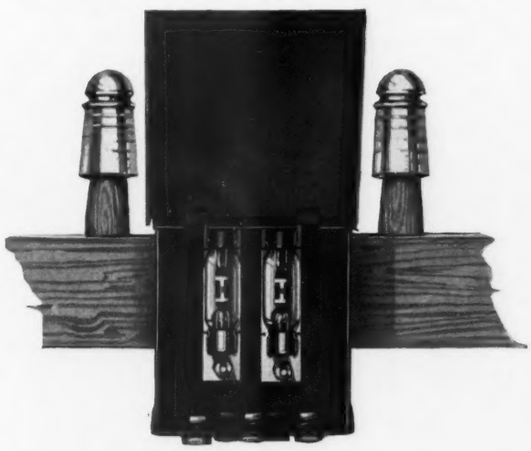
You never know in just what manner this enemy will strike.



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The Bennett Building in New York City is just one of many such buildings in which Haughton Elevators have replaced old elevators of other makes.

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HAUGHTON ELEVATORS

THE MACHINE HELLO GIRL

By G. FRANK LORD
50 Oliver Street, Boston, Mass.

MR. H. P. CHARLESWORTH, plant engineer of the American Telephone and Telegraph Company, in the June, 1921, issue of THE TECH ENGINEERING NEWS, gave in brief the origin and operation of the panel type machine switching telephone system which is now being installed in a number of our larger cities. He described how a subscriber served by one machine switching office may call another subscriber in the same or another machine switching office without the aid of an operator. I shall therefore attempt to give the reader a general idea of the method whereby a subscriber in a machine switching office may obtain a party who is connected to a manual office, and vice versa, how a manual subscriber may secure machine switching stations.

For example, let us assume that a party in the Aspinwall office, which will soon be cut over to machine switching, desires to call a subscriber at BRO klin 1064. He will dial BRO and then 1064, as previously described, just as if he were making the call to another machine switching subscriber. The call proceeds in the same way as an inter-office call between two machine switching offices, through the line finder, sender selector and sender to the district selector frame, where an idle trunk is automatically selected to the desired manual office. The trunk terminates on a single ended cord and plug at what is known as a call indicator position in the manual office. The call indicator proper consists of several groups of small electric lamps covered by a glass plate with a black background on which is a series of translucent characters which correspond to the lamps beneath. The lamps and their corresponding numbers and letters are so arranged that they may display under the control of a set of relays the numerical portion of any number dialed by a subscriber, together with the party line designation, if there be one. Associated with each cord and plug at the call indicator position is a key known as a "display key" and a small electric light called an "assignment lamp." When a call comes in from a machine switching office, the lamp, associated with the particular cord which has been selected at the district frame, will light and thus inform the incoming operator that a call is waiting on that cord. The operator will then depress the display key associated with the trunk and the number dialed will be displayed in the lamp signals before her. The call is thus received by the incoming or "B" operator visually rather than orally.

After noting the number dialed, as shown by the call indicator, the operator completes the connection by taking the plug of the cord on which the call is waiting, first testing to see if the line is busy and, if not, then inserting it into the multiple before her in just the same way that a "B" operator on the manual "B" board would complete a call. In case the line is busy she plugs into a certain jack known as a busy back which causes a busy signal to be returned to the subscriber. When the calling party hangs up, the machine equipment returns to normal, causing a second lamp associated with the cord, and known as the "disconnect lamp," to light. The operator then removes the plug which extinguishes the "disconnect lamp" and the equipment is ready for another call.

The equipment has been so designed that when several calls are received at a certain call indicator position at the same time, the additional calls are stored up in the mechanism until the operator is able to dispose of them. This may be done by completing the call displayed, by plugging into the busy back, or by depressing the "display key" associated with another trunk on which a call is waiting.

Now let us consider the subscriber in a manual office such as Brookline who desires to call a machine switching subscriber in Aspinwall, ASP nwall 0179, for example. The subscriber gives the desired office name and number to his "A" operator as in manual practice. The "A" operator then passes the call over a call circuit, to the machine switching office where it is received by a cordless "B" operator in the manual office, who plugs the calling subscriber's cord into the jack associated with the assigned trunk. We now have the manual subscriber connected to the machine switching office at a cordless "B" position.

The cordless "B" operator instead of completing the call manually by plugging into a multiple, writes the number upon the numerical keys in front of her, which are similar in appearance to those on an adding machine. The setting of these keys causes a "B" sender to function, which completes the call through the incoming selector frame to the proper frame and then out to the particular station.

It is apparent that the introduction of machine switching will not permit of dispensing with operating forces. As has been indicated, only those local calls which originate and terminate in offices equipped with machine switching apparatus will be completed without the aid of an operator. Operators will also be needed for the handling of long distance calls and for the handling of calls to Information and the Repair Clerk. As the machine equipment is only installed in cases of obsolescence or inadequacy of the present equipment, it will be a number of years before all of our central offices in Boston will be converted to machine switching and manual operation of local calls eliminated.

The initial investment in a machine switching office is several times that of a manual office of the same capacity, but as additions are made to the machine office it is estimated that the saving in operating charges will more than offset the additional charge incurred by the use of machine equipment and hence justify its installation from an economic point of view. As the grade service furnished by the machine equipment compares favorably with the manual, machine switching proves its worth from a service point of view.

It has been the experience of the American Telephone and Telegraph Company that in cities where both the machine and the manual service are furnished, subscribers prefer to dial their calls rather than pass them orally to an operator. From a subscriber's point of view, machine switching is desirable; the grade of service compares favorably with the manual and it is expected that machine switching will eventually reduce the operating charges, hence the Telephone Company feel that they are justified in adopting the new system.

Gasoline as a Refrigerant. That natural-gas gasoline can be used to advantage as a refrigerant is suggested by the fact that the "make" tanks and other parts of the equipment of gasoline plants frequently become coated with frost. Experiments recently conducted by the Department of the Interior confirm this assumption and indicate that volatile gasoline can be used to advantage in many refrigerating plants.

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10. Auxiliary police box for connection to Municipal System.

FIFTY years ago a straight fire alarm box on the street seemed to provide all necessary fire alarm protection. As practical conditions were met, various new devices were found necessary.

The extension of the City System into private properties — local alarm systems for local fire brigades — special facilities for drilling separate buildings or parts of buildings where the life hazard was great — all made necessary the design and manufacture of special apparatus which has since become standard.

Such standard apparatus has also been used for special signaling in the New York Subways, the New York Edison, Clyde Valley Power Company, Glasgow, Scotland, and numerous other properties.

Whatever emergency signaling requirements you may meet, there probably is standard apparatus with a service record of years waiting for you. The engineering knowledge which we have accumulated in designing this apparatus is always freely at your disposal.

The Gamewell Company
"A Box a Block."
Newton Upper Falls, Massachusetts.

MATHEMATICS

(*Continued from page 161*)

stood not at all in the sense it was meant.

In words of one syllable, "mathematics" is spelt "IF" in capital letters. The fundamental thought is, IF such and such statements about any ordered class of things are valid, THEN and only then are certain other statements logically deducible from the IF's, also valid, of the same class. That in mathematics we reason only about classes of things that are representable by mathematical or substitutive symbols, and whose relations are representable by the rules governing the manipulation of such symbols is beside the point. The IF and the THEN express the essentially experimental basis of mathematical science, and, indeed, of all science.

Unfortunately, the fundamental hypotheses or postulates of science such, for instance, as Newton's Laws of Motion, have remained unaltered over so long a period, that, like Euclid's postulates, they have become a very definite part of our mental make-up. They are ingrained habits of thought that are very difficult to change. Yet all advance in thinking is based on doubt. The measure of a truth is the doubt it can withstand. Remember that truth is a character of ideas — never of facts or things, which merely are or are not.

Faraday's ideal principles of the electro-magnetic field, as put in mathematical form and extended by Maxwell demand the physical existence of the luminiferous ether. We have thought and worked so long in accordance with Maxwell's equations, that the hypothetical ether has become to us the real background of electrophysics. It simply must be there. But history should show us that when any idea develops to the imperative mood, it serves only to delay progress.

Mathematics begins with a more or less intelligent guess as to the sort of relation that may exist between the elements of an ordered class. This class may be a pure figment of the imagination brought together merely to try out the logical implications of the guess. If these implications (the THEN's) fit together without confusion and are altogether consistent with one another, then well and good: the resulting mathematics is perfectly sound, and the guess was a good one.

If it is possible to go back of the guess and find another element or elements on which the guess can be made to depend, then the guess was itself subject to analysis, and is not the fundamental basis of the argument. When in this way the first element is found and known to be the first because it cannot be made to depend on anything of the same kind, it is dignified by the appellation "postulate." There may be more than one postulate. In which case it is merely required that they be logically consistent with each other. But they must not be dependent on one another. The postulates are the IF's. Since they cannot be proved they must be assumed and taken for granted.

This is why the game of mathematics casts shadows on chess, on whist, and on a whole lot of other games, except sail boats and girls. It is never certain about the beginning. Then how about the end?

Not so many years ago, Lobatschewsky attacked Euclid's very important, and to him, very necessary, parallel postulate, and assumed its negative as an equally valid starting point. Lobatchewsky and his successors let loose a flock of new geometries. You see, according to Lobatschewsky's method, if you hit on a good substitute for the parallel postulate, you get a new geometry. All of which is logically sound.

If you think a little closely you will realize that the space in which you live is not made up of points and lines and planes *à la* Euclid, and that, as a matter of fact, no one ever experienced such things unless as figments of the imagination. None of this affects either the truth or the validity of Euclidian Geometry, but merely its value as a means of describing all the aspects of physical space. Even so conservative a mathematician as Gauss seems to have had doubts as to the Euclidian character of physical space.

In abstracting his spacial experience Euclid seems to have left not even the skeleton behind, but only a rather tepid ghost. He took time out of his space and left us something to live in that had no duration. But if any one thing vitalizes physics (and engineering) certainly it is time. An instantaneous cube or sphere would be a very ephemeral object. An instantaneous flywheel would hardly be said to possess momentum. Actually, its existence would be entirely outside our comprehension. So, to be in any sense real, objects in space must have some duration, however small, inextricably bound up with their spacial elements. Even a point, to be a point in real space, at least must last a little while.

Thus, Minkowsky points out that the space we actually live in is a four-dimensional space. There is no mystery about its length, breadth, thickness and duration, its x, y, z, and t. Only we have become so prejudiced by several centuries of Euclid, that we do not recognize our own home when it is shown to us.

Century old habits of thought and conceptions cannot be overcome in a day, and so this "t" dimension is quite "imaginary" to us, who insist that we live and work in three "real" dimensions. There is nothing strange in this, for when we arbitrarily limit ourselves to two real dimensions — the x and the y — the third dimension, z, becomes imaginary. Or if we go one step further, and work in one real dimension, say the x, then the y becomes imaginary also. The presence of imaginary dimensions thus indicates that we have imposed an unnatural limitation on space. If we enlarge the scope of our space the imaginary dimension becomes quite as "real" as any other. It is for this reason that Minkowsky represents the four dimensions of real physical space by x_1, x_2, x_3, and x_4, and in this representative space, the existence of a point is indicated geometrically by a line.

The so-called theory of relativity is the body of logical implications deduced from the assumption that every "law of nature" must hold, irrespective of the particular sort of space geometry used as a means of mathematically expressing such laws. It follows that only those mathematical forms that are valid in every and any space geometry can be assumed to correspond with natural laws. Of these there are very few. But having determined one, say the generalized law of gravitation, then, if the actual detail form of this law at any point, or in any region of physical space be established, the presumption is that the sort of space actually existing at this point, or in this region, is thereby determined. The value of the theory is measured by such tests. And after all, is not this method very rational, and very much a matter of common sense? If we be wise, we live just such a sort of plastic existence, as well as may be fitting ourselves into the sort of environment in which we find ourselves. Fortunately, life is not rigid and composed only of moral straight lines and mental planes. It is quite as flexible in its structure as the Einsteinian space "mollusc."

The result of this radical step is to construct a geometry of space and mathematical methods, the resulting implications of which (the *then's*) appear to approximate more closely to physical experience than could be obtained by mathematical methods based solely on the three dimensional straight line space of Euclid, with time arbitrarily added as a sort of parasite.

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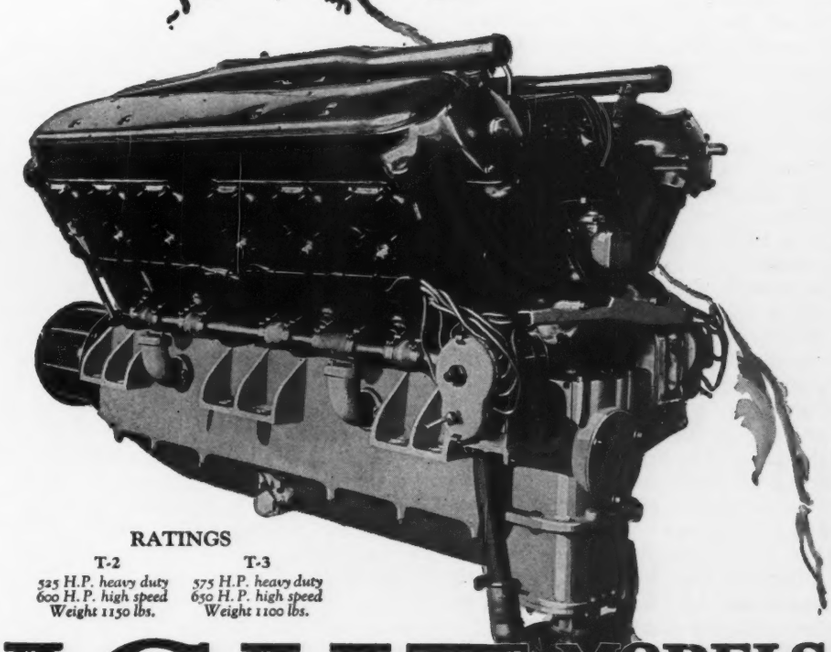
Paterson, New Jersey, U. S. A.

"The Identification of Incomparable Service"

Efficiency tests disclosed that fuel and oil consumption of the Wright "T" engine in flight corresponded very closely in gallons to the consumption of a smaller engine in the same plane. The efficiency of the "T" throttled down to flying conditions compared most favorably with the comsumption tests of smaller engines.



RATINGS

T-2	T-3
525 H.P. heavy duty	*575 H.P. heavy duty*
600 H. P. high speed	*650 H. P. high speed*
Weight 1150 lbs.	*Weight 1100 lbs.*

WRIGHT MODELS T ENGINES

PORT NEWARK TERMINAL DEVELOPMENT

(*Continued from page 166*)

over to the United States Government. The United States Shipping Board, Emergency Fleet Corporation, leased the lower portion on the bay front (one hundred and thirteen acres), and consigned the lease to the Submarine Boat Corporation for a shipyard, and the remaining area (one hundred and thirty-three acres) was purchased by the government for the construction of an Army Supply Base.

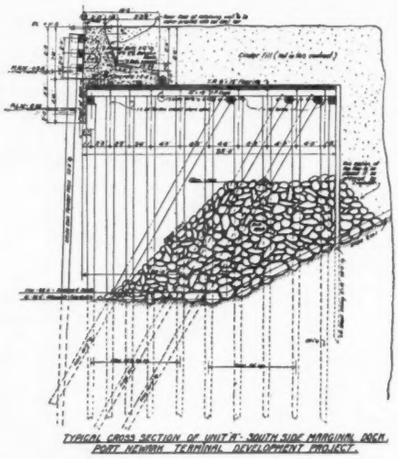
Directly after the government started construction (1917), the marginal dock burned to the water level, from a cause not yet determined, and the city was obligated to supervise and partially stand the expense of reconstruction, which was started immediately.

The government channel in Newark Bay was at that time three hundred feet wide and twenty feet deep at mean low water, and despite the efforts made by the city of Newark to have this channel deepened by the federal government, Congress refused to authorize an appropriation for such work. The urgent need for a thirty-foot depth through the bay to accommodate large ships coming into Port Newark was realized by Commissioner Thomas L. Raymond, Director of the Department of Streets and Public Improvements, who wisely decided to obtain a permit from the War Department for the deepening of the bay channel to be done by and at the expense of the city of Newark. The permit was obtained and a contract was awarded to the Atlantic, Gulf and Pacific Company for the additional dredging of the government channel from the junction of the Kill van Kull (Bergen Point), to Port Newark Terminal, a distance of twenty-four thousand feet. This project was recently completed, and Newark now offers, at high water, a thirty-five-foot depth from Port Newark to lower New York Harbor, or approximately seven miles.

Since the termination of the World War, the government has had but little use for the Supply Base and the city of Newark seriously considered the acquisition of the warehouses and other improvements built by the government during the war emergency.

Director Raymond has recently concentrated his efforts in the attempt to prevent the reconstruction of the New Jersey Central Railroad bridge across lower Newark Bay, and he has presented to the Secretary of War detailed estimates for re-routing or tunnel construction in place of the proposed new bridge. The existing bridge has been condemned and the railroad company plans to construct a new bridge in accordance with plans approved by the Secretary of War and the permit granted by the government for the construction of same. Newark has greatly opposed the erection of a new bridge, claiming that it will be a menace to and cause delay in the future commerce navigating Newark Bay and its tributaries. The elimination of bridges is a problem confronting every port development, affecting navigation and railroads to such an extent that it seems obvious that they should, where possible, be substituted by tunnels, thereby decreasing the delays now suffered by both means of transportation, not to mention the cost of repairs due to accidents occurring through the operation and navigation of drawbridges.

With the developed area of Port Newark occupied, the city has started to develop the area on the south side of the city channel. Reclamation was



TYPICAL CROSS SECTION OF UNIT 'A' SOUTH SIDE MARGINAL DOCK, PORT NEWARK TERMINAL DEVELOPMENT PROJECT.

effected the same as on the north side, but due to the extreme distance between the dredges in the government channel and the disposal areas the material removed from the government channel was transported in scows to a dumping basin in the city channel, and rehandled by hydraulic dredges and pumped ashore. Contracts have been awarded for further dredging operations and the construction of a marginal dock. The present dredging operations will widen the city channel at the inshore end to six hundred and seventy feet for a distance of one thousand feet easterly, and the new dock will extend over the same distance. Such construction will be the initial step to develop a piece of land with one thousand feet of waterfront and one thousand six hundred feet of depth, offering deep water and rail service for industrial purposes.

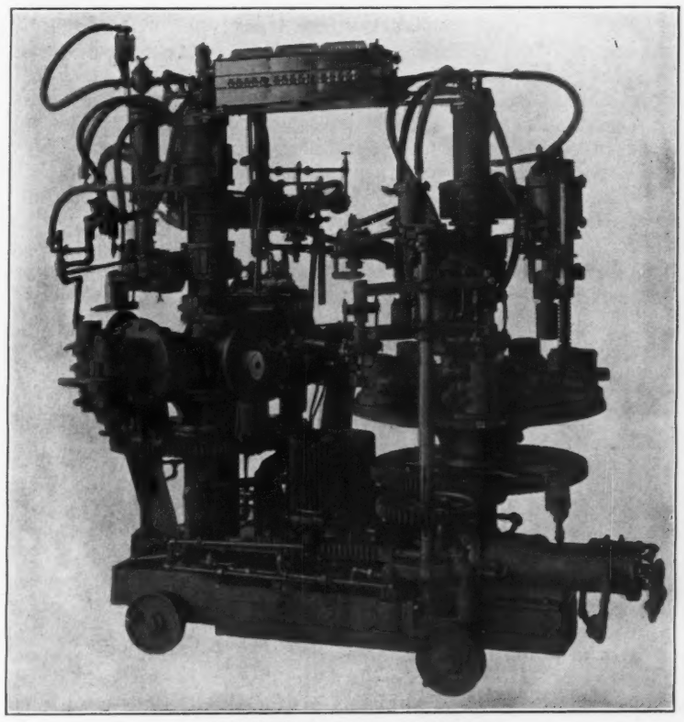
After considerable study and investigation of various dock designs, the city of Newark finally adopted the relieving platform type of marginal dock. Several important factors in this design were outstanding and advantageously used from an economic viewpoint.

Fortunately, Newark Bay is not infested with the teredo worm and as we feel reasonably assured that enough pollution will always be present to resist the habitation of the marine borer, it was, therefore, decided that untreated timber piling could be used for the sub-structure. Borings indicate that rock exists in very few parts of the dock and pier locations and where found the overlying strata of dense clay is deep enough to insure the required lateral stability.

As indicated on the accompanying cross-section, the pile cut-off is at elevation of 1.5 above the plane of mean low water. The pile bents are placed on six-foot centers, carrying a six-inch timber deck. The most important detail of the entire design is the stability and resisting power offered by the bulkhead retaining the cinder fill placed in back of the structure, and the safety of this bulkhead is largely dependent upon the proper penetration of the eight-by-twelve-inch sheathing. These sheet piles must be driven deep enough to prevent a "blow" from underneath, which means that the passive pressures on the water side must be great enough to resist the active pressure of the fill on the land side. This condition is realized by the thirty-five-foot sheathing length, the placing of the brace piles as shown on the cross-section, and the section of riprap placed under the platform. The bottom of the dredged cut for the twenty-six-foot depth is carried under the platform a distance of twenty feet from the dock face, to create a level bearing surface for the riprap, thereby eliminating the possibility of any sliding action of the riprap section, even when a thirty-five-foot depth is made along the face of the dock. In addition to reinforcing the resistance of the bulkhead, the riprap section materially strengthens the platform by providing lateral support to the piling in general. Naturally, the design indicates that some resistance is offered by the pile bents extended from the bulkhead, but such resistance is not relied upon, as any lateral stress absorbed by the platform structure would greatly tend to result in poor alignment of the concrete wall placed along the face of the dock to retain the platform fill.

It will be noticed that a concrete fire protection apron extends below the plane of mean low water at the face of the platform, preventing the

(*Continued on page 182*)



A MODERN BOTTLE MOLDER

The Glass Bottle

TO most people it means the world's most sanitary container, urgently desired when its use is necessary. Little thought, however, of other than a utilitarian nature is given to the bottle itself and few consider its manufacture. Yet to a select number, it is the practical fulfillment of many years of careful and exhaustive study and experimentation.

For behind the glass bottle is the automatic molding machine, with which skilled workmen rapidly produce this necessity. The device is the nucleus of the bottle industry and upon it has been lavished infinite experience and research in order to perfect its product.

The SALEM GLASS WORKS, pioneer bottle manufacturers, have not only contributed much towards supplying the ever increasing demand for better bottles, but they have, as well, made numerous improvements on the bottle molding machine. Their staff of engineers and experts is ready at all times to give their prompt attention to your container problems and requirements.

SALEM GLASS WORKS

SALEM, NEW JERSEY

PRODUCERS OF BETTER BOTTLES

PORT NEWARK TERMINAL DEVELOPMENT

(*Continued from page 180*)

possibility of burning floating oil coming in contact with the superstructure or piling.

Experience has taught us that timber construction extending below the plane of mean tide will not decay and the dock is designed so that no part (except the perishable fender system) is exposed to the air for more than two and one half hours between tides, and will therefore be saturated with water.

After the timber construction is completed, the cinder fill is placed on the platform and behind the bulkhead to the finished grade of elevation eleven, and on such fill is placed paving, railroad tracks, and other dock equipment.

The construction of this type of dock is economical, costing at this time and in this locality approximately two hundred and forty dollars per lineal foot, exclusive of paving, railroad tracks, etc., and it is obvious that the cost of future maintenance is negligible.

As the waterfront is leased, or otherwise occupied, another section of dock, one thousand feet long, will be added and the channel widened. This sequence of operations will eventually expand the development to the bay front where three large modern piers, each one thousand two hundred feet long and two hundred and fifty feet wide, will be extended from the city bulkhead line to the government pierhead line.

The activities of the city of Newark and its plans for the future of Port Newark have convinced the War Department that a suitable public terminal will be created and the Secretary of War has received, and acted favorably upon, recommendations for extensive dredging operations in Newark Bay under the supervision and expense of the federal government.

SYLPHON TEMPERATURE REGULATORS

(*Continued from page 164*)

The "trapped vapor" feature of Sylphon temperature regulators should be of special interest. This construction utilizes all of the thermo-sensitive liquid in the bulb of the regulator to produce movement of the regulating valve. Without this feature, no regulator can utilize more than a part of the thermo-sensitive liquid. This gives less bulb mass to be heated and cooled each time the regulator operates, hence greater sensitiveness and more power. A small flexible conduit leads from the bulb to the Sylphon bellows and transmits the pressure developed in the bulb to this bellows. The flexible connecting tube extends down on the inside of the regulator bulb and is so arranged that its inner end shall always be immersed below the surface of the thermo-sensitive liquid, thereby constituting what we term our "trapped vapor" construction, preventing any of the vapor formed in the bulb from passing over to the bellows and insuring that the power shall be transmitted entirely by liquid pressure. If vapor were allowed to pass over into the bellows, the latter being cooler than the bulb would act as a condenser, causing this vapor to condense, and no pressure could be built up in the bellows until sufficient liquid had been distilled over into the bellows to fill it. On the reverse operation, it would be necessary for all liquid in the bellows to be redistilled back into the bulb, whereas vapor is very elastic, it will be evident that transmitting this power through the means of the liquid insures positive action at the bellows. This pressure feature is covered by Letters Patent and cannot be rightfully used by any other manufacturer.

In installing the regulator, the bulb is exposed to the air or liquid whose temperature is to be controlled, and the valve is mounted in the pipe line which supplies steam or other medium to the heating coil, which heats the air or liquid.

For controlling liquid temperatures, the thermo-sensitive bulb is furnished, or is made of seamless drawn tubing approximately one inch in diameter and sixteen inches long.

Bulbs of all regulators for controlling air temperatures are of star-shaped construction, which have been demonstrated both in theory and practice to give greatest area of exposed surface in proportion to cubical content and mass, of any design known. The specific heat of air is approximately four times the specific heat of water; hence the greater bulb area required in controlling air temperatures.

A description of the No. 932 type of Sylphon Temperature Regulator should prove of interest, as it represents the most recent development or improvement in the self-contained type of temperature regulators. This instrument combines all of the functions of the regulators heretofore described in this article, with the additional improvement of having the flexible tubing in a separable unit. In actual service, the flexible tube which connects the thermo-sensitive bulb with the Sylphon bellows or power element is likely to be broken, in which case it is necessary to remove the bulb from the tank, returning it, together with the flexible member, to the factory for repairs. This, of course inconveniences the customer and considerable time is lost while the regulator is in transit. The No. 932 Sylphon Temperature Regulator, which we have designated as the "Detachable Tube Type 2," is designed to obviate this trouble. It consists of three distinct and separate parts: the steam valve, to be placed in the steam line; a transmission unit; and a thermo-sensitive part. The thermo-sensitive part consists of a bulb designed to be placed in the tank and has communication with a flexible member, the opening movement of which is opposed by a temperature adjusting mechanism, consisting of a spring and a hand wheel, operating on a screw threaded stem so that by turning the hand wheel, a greater or less force is exerted against the flexible member, as the requirement may be. The steam valve is placed in the steam line in the usual manner. The separate transmission unit may then be readily attached to the steam valve and the thermo-sensitive part by means of a T-head and T-slot, and by tightening the two nuts the unit is clamped in place. If, by any means, the tube should be broken, a new detachable transmission unit may be bought and installed without removing either the thermo-sensitive part or the steam valve. With this type of regulator the power exerted by the thermostatic member is transmitted to the valve unit by liquid pressure acting between two small Sylphon bellows. This member is completely filled with an incompressible non-freezing liquid, and any force exerted at one end of the member is communicated to and produces a corresponding movement at the other end. These features are covered by broad patents and are possessed by no other regulator on the market.

The applications or uses of the foregoing types of temperature control instruments are innumerable, and broadly speaking, may be used for controlling temperature of air or liquids wherever hot water or steam is used as the heating medium. The following list of well-known applications will serve to give the reader some

(*Continued on page 184*)

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with case

The new model Corona, five years' guarantee

Engineering and Chemical Keyboard

Fifty-one different keyboards, including twenty-two languages. If you want a typewriter that will stand up buy a Corona.

Seventeen years of continual use without a single "poor" model. Many seventeen-year-old Coronas doing good work today, some without a penny for repairs.

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Telephone Main 3927 and we will send demonstrator
Ask for booklet No. 20

E. C. M. A.

The Engineering College Magazines Associated

An organization of the eighteen leading college technical journals of the country; it was founded for the purpose of raising the standards of college engineering journals and in this way serving to better advantage the alumni and undergraduate engineers, and the advertisers desiring to reach this field.

There are *twenty-five thousand* subscribers eager to know all about the latest developments in commercial engineering to whom no better or more pleasing approach can be made than in their own college magazine. There are *fifteen thousand* student subscribers anxious to know and understand the concerns they will be affiliated with when they graduate.

THE TECH ENGINEERING NEWS, as founder of this group, stands ready to coöperate with any engineering concern desirous of reaching the most fertile field of potential users of engineering equipment ever brought together for the service of the advertiser.

The same advertisement on the same size page appears at the same time in eighteen college technical journals

"Safety Always"

Who said America couldn't top the world in making Gage Glasses?

Didn't the World War show us that we need not play second fiddle to any nation, in anything? Libbey American-made High Pressure Gage Glasses are not excelled anywhere in the world. They are made by a concern with over a hundred years experience in glass manufacture.

They have passed the most radical and exacting tests ever given a gage glass—temperature tests with sudden temperature changes, steam erosion tests, hydraulic tests.

Guaranteed unconditionally for pressures up to 400 lbs. and as to permanent, crystal clearness in service. Also as to uniformity of size. Made with fused ends. Sold in packages of one-half dozen. Try them, as so many others are doing. You know what your "homefolks" can do.

LIBBEY GLASS MFG. CO.
TOLEDO, OHIO

SUPERPOWER SYSTEM

(*Continued from page 169*)

today is power generation in small power units. These small power units should be abandoned by the substitution of super-power zones, and the construction of these super-power systems will be greatly aided by water-power on the St. Lawrence River and elsewhere.

Thus, it is planned that the resources of Niagara and of the St. Lawrence be tapped. Such a system, together with the entire substitution of large "super-power steam plants" for all small steam plants now in operation in the zone, will have a bearing upon our industrial life that will be little short of an industrial revolution.

Power is a fundamental need of our life today, and hydroelectric power is the most satisfactory form of power known because of its reliability and practical freedom from strikes and its freedom from transportation difficulties. The power will, in the case of the super-power plan, be transmitted by *wire* instead of in coal cars.

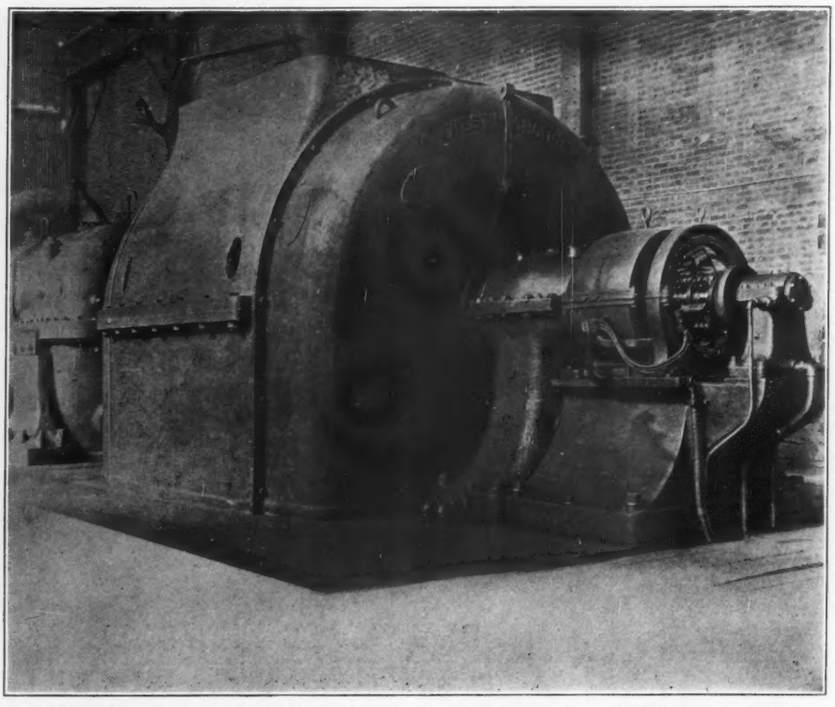
Practically all water power now devoted to public utility use in the United States, and all water power to be hereafter developed, is, and will be subject to regulation by public authority of rates, service, and securities issued. In other words, the representatives of the consumers fix the prices, the consumers pay for their power, as well as the character of the service to be rendered.

In 1920, after a ten years' battle in Congress, a Federal Power Law was enacted for the United States of America. The same bill, word for word, could have been enacted in 1910 and many millions of dollars in labor and transportation costs could have thus been saved. The excuse most frequently given by senators and congressmen during the ten years' delay was: "Yes, your arguments are sound, but there is no sentiment in this country for such a federal water power law." Surely, from somewhere in government circles in Ottawa and Washington, leadership will spring up that will forbid such delays regarding the St. Lawrence navigation and power project as occurred with our Federal Power Law.

The territory in which the super-power survey has been made — the "super-power zone" — may be described as lying between the thirty-ninth and forty-fourth parallels of latitude and extending from the coast approximately one hundred and fifty miles inland, enbracing parts of the State of Maine, New Hampshire, Vermont, New York, Pennsylvania, Delaware and Maryland and all of the States of Massachusetts, Rhode Island, Connecticut and New Jersey. Within this zone is concentrated one fourth of the population of the United States, and within this zone are operated, most of them independently, three hundred and fifteen electric utilities, eighteen railroads and ninety-six thousand industrial power plants. Fortunately some of the best coal mines and deposits in the entire country lie near this great industrial territory, and a prime economic purpose should be so to conjoin the hydroelectric supply of power to the steam-electric supply as to produce a maximum of energy for a minimum investment of capital and a minimum of operating expense, and at the same time to conserve the rapidly disappearing cheap fuels of the Appalachian coal fields.

The super-power system, as recommended, comprehends a plan of power production that includes the generation of electricity by steam at tidewater and on inland waterways, where a sufficient quantity of condensing water can be obtained, and also the utilization of all hydroelectric power that may be economically obtainable from rivers within the zone or within transmission distance of it. The electric power so generated will be coördinated through a system of interconnected transmission lines, the potential of which will be on the order of two hundred and twenty thousand volts, and sometimes only one hundred and ten thousand volts.

The super-power system would — and should — fail to achieve its purpose if it should seek to supplant or to compete with the existing electric utilities. Its primary object is exactly the reverse. The creation of the super-power system can be urged only as it shall come into being to coördinate and supplement these utilities.



25,000 H. P. STEAM-ELECTRIC GENERATOR OF THE ALABAMA POWER COMPANY IN THEIR STEAM POWER PLANT NEAR GORGAS, ALABAMA

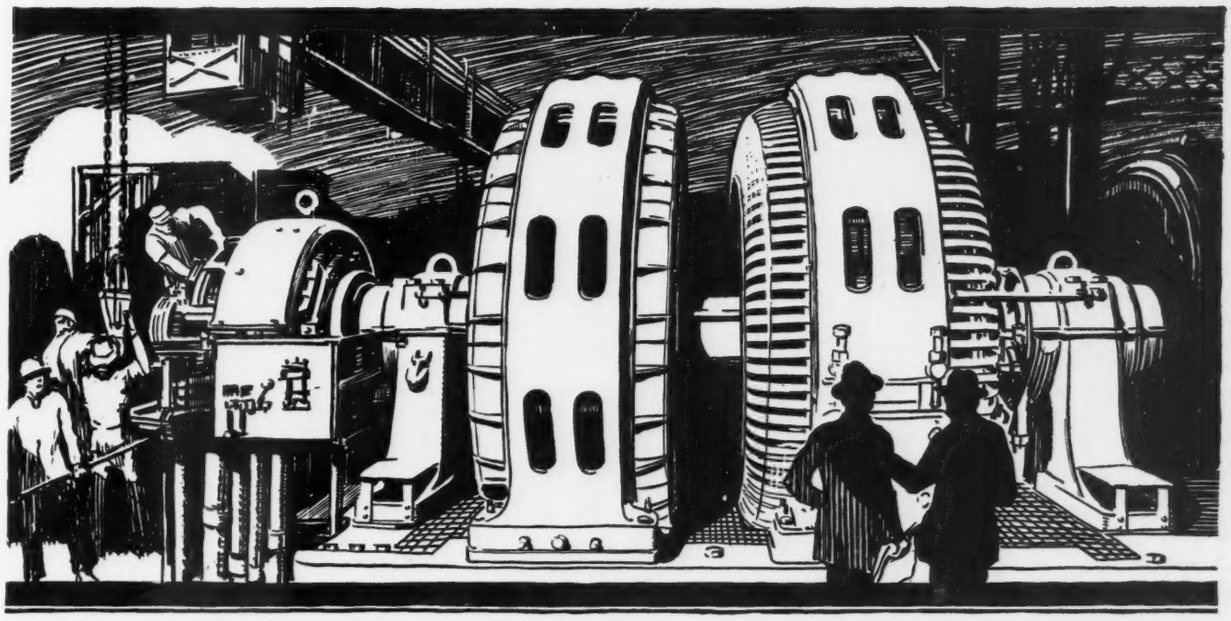
TEMPERATURE REGULATORS

(*Continued from page 182*)

idea of the many uses which may be made of Sylphon Temperature Regulators:

Hot-water storage tanks, dry kilns, warming ovens, proofing rooms, pasteurizing and sterilizing apparatus, cold-storage rooms, cooking vats, retorts, size boxes, tempering tanks, condensers, stills, percolators, fuel-oil heaters, feed-water heaters, gas engine water jackets, tanning vats, glue kettles, sugar refining apparatus, etc.

A chart by which proper valve sizes of temperature regulators may be easily and quickly figured will be gladly furnished by the manufacturers on request. Address The Fulton Company, Knoxville, Tennessee.



Real Service Must Be Engineered

Many of the men whose names are writ large in engineering history are design engineers; men like Westinghouse, Lamme, Stanley, Hodgkinson, Tesla, Shallenberger. Their inventions have the quality of usefulness, of reliability, of productability; which is an involved way, perhaps, of saying that they have the primary requisite of all really great inventions: *Serviceability.*

Engineering history abounds in instances of near-genius that produced no product, and of great developments that never reached completion; and most of these instances are explained by the lack, somewhere in the system, of that ability to give real Service.

Service, in a machine or a system, or wherever you find it, is not there by accident but because it was incorporated by men who understood what was required and knew how to provide it.

Much more is required of the designer than facility in calculation and mastery of theory. He must have first hand and thorough familiarity with manufacturing operations and with commercial and operating conditions. It takes more than mere ingenuity and inventiveness to design apparatus that will be really serviceable and will "stay put."

The design engineer, in the Westinghouse plan, is responsible for the performance of the finished product. He cannot possibly have the proper understanding of operation unless he operates and tests, unless he spends time and thought in investigation and study, not in the laboratory or drawing room, but right on the operating job. Here, most of his ideas will develop; and here he will see and prepare for all the different things which the product will later have to encounter. Then when he comes to put his creations on paper, his calculations will be necessary and helpful to check the conclusions which he has reached, and this right use of them requires training and a high degree of understanding. This proper balance of the physical and mathematical conception of things is what constitutes engineering judgement.

It should be thoroughly understood that the primary function of the design engineer is the conception and the production of new or improved apparatus, and familiarity with the practical is essential to the proper discharge of this duty.

It is this view of designing that makes this branch of Westinghouse engineering so important, so effective, and so productive of real developments.

W WESTINGHOUSE ELECTRIC
Westinghouse
ACHIEVEMENT & OPPORTUNITY

FRANCIS A. WALKER

(*Continued from page 163*)

distinctive institution recognized as a leader in the United States and attracting many students from all over the country, as well as from abroad. He unified his faculty by giving them freedom and initiative; stimulated his corporation by sharing with them the duties of administration; fostered an enduring loyalty among his alumni; gave his undergraduates, through his general and personal talks to them, high and vivid ideals of manly responsibility; and established on foundations which after his far too early death could not be undermined or shaken, the absolute independence of the Institute. Incidentally, he quietly liberalized its methods; broadly developed the principle of laboratory teaching in which the school had been so notable a pioneer; entered new fields of teaching, such as electrical engineering, sanitary engineering, chemical engineering and naval architecture; and transformed the undergraduate body from pure "grinds" into men with an interest in healthful sports, seeking those social contacts which are a major factor in education, and imbued, as he himself was, with an eager spirit of service to mankind.

Walker was a singularly handsome man, with coal black hair and mustache, later tinged with grey, and with eyes so reflecting the man's soul within that, once met — and his gaze was absolutely direct — they could never be forgotten. His military experience had left him with a notably erect bearing, a somewhat formal, though thoroughly cordial, manner, and not merely a capacity, but an appetite for detailed and multifarious work. While carrying forward his exacting duties at the Institute, he rendered much public service: in Washington, to the government, in Massachusetts as a member of the State Board of Education and on special commissions, and in Boston, as a tireless worker on such bodies as the School Committee, the Park Commission and the Public Library trustees; was ceaselessly writing books on economics and history; was frequently lecturing to the students, before the Lowell Institute, and to outside organizations; was in continual demand as a eulogist of great men and as a writer for the magazines; and night after night, when he should have been in bed, was speaking at dinners where he felt it his duty to represent the Institute. Moreover, this enormous volume of work was carried on under most difficult conditions. The typewriter was in its infancy, neither the Institute nor Walker himself could afford to buy one, and, until the very last years of his presidency, he refused to employ even a clerk, maintaining that if every one else at the school must exercise the most rigid economy, it was his place to set the example. So he carried on his prodigious correspondence and other writing with his own pen, or through the labors of his devoted family, often working in his library at 237 Beacon Street far into the morning hours. Moreover, during the first three years of his presidency, pending the completion of the "New Building" (that now occupied by Boston University), he did not have even an office of his own, but was squeezed into a small corner, lighted by only half a window, of the secretary's room. When he acquired an office, however, its door stood wide open and every visitor, thus invited, was welcomed as courteously and listened to as patiently as though the overworked President had nothing else to do.

The inevitable result of such hard and distracting work under difficult conditions, of his ceaseless anxiety concerning the finances and the future independence of the Institute, of his traveling around the country and his attendance upon "banquets" in obedience to what he believed to be his duty to make the Institute known, was a progressive exhaustion which hurried summer journeys to Europe could not repair and which gave his friends the gravest concern. A tiring trip to speak at a dedication, followed by a journey to Washington to attend a meeting of the American Statistical Association, proved too much for his overstrained body and brain. Early in the morning of January 5, 1897, he died, without struggle or suffering, as the result of apoplexy, being still a comparatively young man of fifty-six.

Because of uncertainty as to the Institute's location, twenty years elapsed before the money almost immediately subscribed by the sorrowing alumni and other friends of the great third President of the Institute could take shape in the Walker Memorial. That building stands today in simple, but rather lonely, dignity overlooking the Charles River and the Boston which Walker loved and for which he did so much. It will become eventually, however, the centre of a group of buildings devoted to the more personal side of undergraduate life. It is a worthy monument to a singularly great man, not only because it is architecturally solid and fine, but because it represents those things which Walker taught and, in his own person, so well exemplified. Few men have loved and eagerly followed clean, manly sport as he did. He never missed, if he could help it, the big football contests; he knew the names and "points" of every leading amateur, not only in football, baseball and tennis, but in cricket as well; and from his first coming to the Institute, he gave himself unreservedly to building up track sports (which he maintained were the best for Institute men, too busy and too scattered for the creating of "varsity" ball teams) so that by 1888 a school that, until 1882, had done practically nothing on the athletic side, emerged as a New England champion. And since his time there has developed an excellent athletic system at the Institute, based on Walker's initiative and planning, which now embraces in active, recreative sport more than half the undergraduate body.

President Walker was an ardent advocate of the educative value to young men of getting together with like-minded fellows, not only in sports, but in argumentation, in the give and take of conversation, in all the contacts which one associates with the best type of club. The Memorial to him is now, and will still more become, such a student clubhouse as he hoped that, some day, Technology undergraduates might have. He was keen concerning the physical and social well-being of young men, and did all that he could to mitigate the discomforts of boarding and lodging-house life which was all that was available to the non-resident Institute student of his day. The Walker Memorial is only on the threshold of its usefulness as the focus of an extensive, self-governing dormitory life.

General Walker frequently stressed the fact that the "Institute is a place for men to work and not for boys to play" and was always advocating the importance of giving young men responsibility and holding them to high standards of achievement. As I have said elsewhere:*

"More than anything else, the war matured Walker, as it did most of his contemporaries, far beyond his years. . . Before reaching twenty-five he had met responsibilities seldom encountered, under normal conditions, by mature men of large affairs; in the years when most youths are quaffing thoughtlessly the wine of life, he had been daily face to face with death. Moreover, he had been admitted hourly to the counsels of his elders upon matter of gravest import to the country, had seen his judgments accepted, and had been taught that wisdom is far less a matter of years than of hard thinking and grave study under circumstances of compelling stress.

(*Continued on page 188*)

*Quotation from Mr. Munroe's biography, "A Life of Francis Amasa Walker," which every true son of Technology should read and then reread.—Editor.

Avoid Guesswork— This Bulletin Will Help

A hand level and a tape are all you need to calculate accurately the correct amount and distribution of explosives for most well-drill shots.

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Guesswork is often relied upon in loading well-drilled holes, but even when the guess is based on long experience, it seldom attains scientific accuracy. A little figuring beforehand will save a lot more than the cost of the time it takes to do it.

Other chapters of this bulletin which is published by the Hercules Powder Co. discuss the comparative effect of different explosives in both pocket and column loading and special methods by which unusual blasting problems have been solved. It also gives record systems used at open pit mines and quarries, and a set of useful tables.

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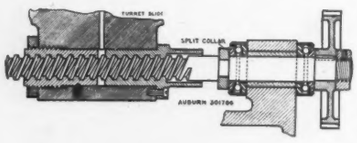

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(Continued from page 186)

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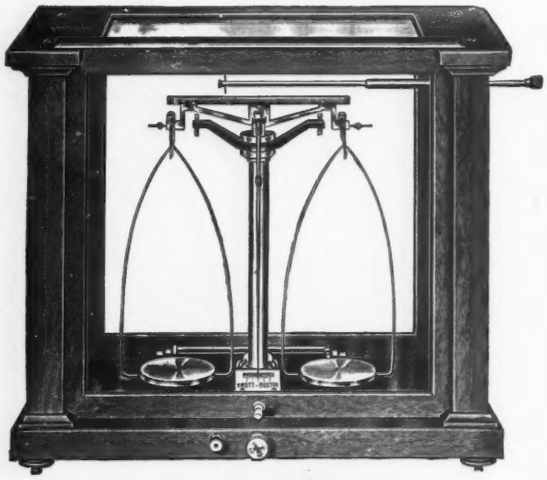

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BUNTING
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GUNITE IN METAL MINES

(*Continued from page 167*)

to prevent foul air, noxious gases, and timber gas from mixing with the fresh mine air.

Experiments proved that gunite adheres to ordinary wet mine timbers. If the timbers are roughened, the degree of adhesion is increased. The properties of gunite and of wood, especially their respective elasticities, differ widely, and if no reënforcing is used a slight jar, swelling, or crushing of the timber cracks the gunite. The cracking makes gunite useless, as it slabs off the timber. By adding reënforcing, such as poultry wire or metal lath, the tensile strength of gunite is increased to the point where it resists readily any sudden changes in the timber. Mine timbers should, therefore, always be covered with wire reënforcing before they are gunited.

Metal lath is often used for underground timbers on account of the ease in shaping it. For flat sides, large timbers, or walls, the poultry wire netting is preferable. Large mesh wire is preferable to small mesh. It is essential to permit a free rebound of part of the sand, in order to avoid sand pockets, and to get a true reënforcing effect of the wire by having part of the gunite lie between the timber and the wire. The wire, therefore, should not be stretched tightly over the timbers.

Timbers should always be sprinkled before guniting. The sprinkling of rock faces is generally undesirable. Clean rock faces are essential, however, and if the rock faces are dry and dusty, the sprinkling is beneficial unless rock swelling results. Where rock faces are excessively wet, the shooting of a thin coat of sodium silicate (water glass) on the rock with the gun, following immediately with the gunite, is advocated by the general manager of the Cement Gun Company. The practice of the Anaconda mine is to use gypsum for the first coat on wet rock faces.

In most tests a mixture of three parts of clean sharp sand to one of Portland cement was found to be preferable. When quick setting was desired, a ratio of two and one-half to one was used. Mixtures of four to one were tried but proved less satisfactory than the three to one mixtures for ordinary work. The three to one mixtures gave the best results for both rock and timber work. Various grades of sand screened through one-half inch screens were used at the four properties.

River gravel, weathered granite and two stamp-mill sands were used. In each case the resulting gunite was satisfactory. Gunite made of the fine stamp-mill sands at the North Star and Empire mines had a glazed finish and set more closely than gunite made from coarser sands, and was tough and highly resistant to blows. The sand and cement should be mixed thoroughly before the mixture is put into the gun hopper. The more thorough the mixing, the more sand voids are filled with cement, and the better the gunite will be.

The sand should not be used too dry, as dry sand sets up static electricity in the material hose, which produces shocks that make holding the nozzle very difficult; moreover, there is danger of the segregation of the mixture in the hose. From five to ten per cent of the moisture content has been found to overcome these difficulties. If the moisture is in excess of fifteen per cent, the material hose clogs easily. Both hand mixing and mechanical mixing were tried in the experiments. The latter was very satisfactory and is recommended for large jobs. The best results are obtained by using the mixture in the cement gun immediately after mixing, as lumpiness is thus eliminated and there is no waste material. Mixing should be done on the surface where possible, as it is a dusty operation. In the present experiments the mixture was delivered in cement bags, and loose in mine cars. The latter method was preferred as being cheaper, although in mines having skips, bags will probably be used if mixing is done on the surface.

Water used in guniting is added at

(*Continued on page 192*)

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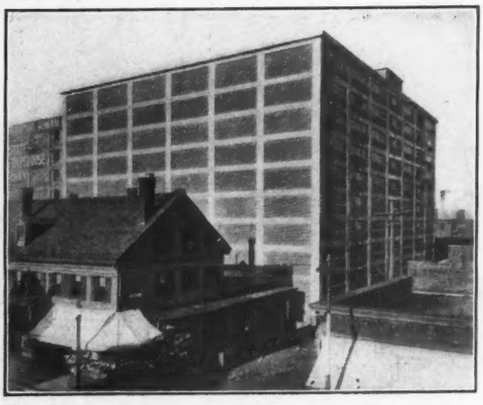

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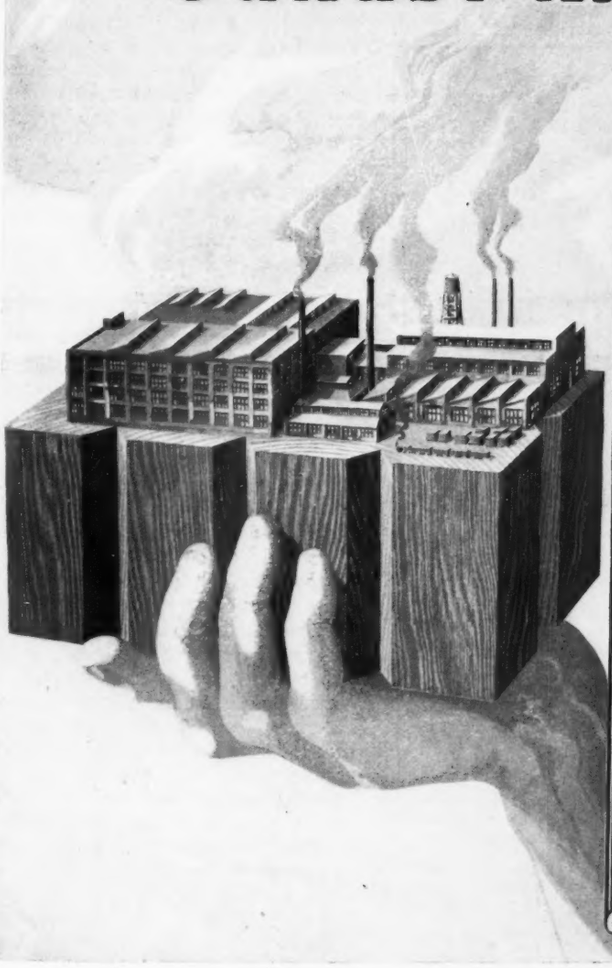

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WOOD BLOCK FLOORS

GUNITE IN METAL MINES

(*Continued from page 190*)

the hose nozzle, that is to say, a dry mixture of sand and cement passes through the gun and through the material hose to the nozzle, where water is added in proper proportion to insure adhesion of the gunite to the face of the rock and timber surface. Four to five gallons of water per minute should be available. As the water joins the mixture within the nozzle, the water pressure must exceed the air pressure by about twenty pounds. In each experiment mine water was used. In mines where the water is either acid or strongly alkaline, it would not be advisable to use it, as the best permanent qualities of gunite are obtained with relatively pure water. The writers did not find any appreciable variation of effect on the gunite from a range of water temperature between fifty and seventy degrees Fahrenheit.

The air pressure required for the operation of the cement gun varies with the length of the hose, the kind of work being done, and the distance at which the man holding the nozzle must stand from the shooting surface. In each mine in which the authors experimented the maximum air pressure was about ninety pounds. The gun required one hundred and fifty cubic feet of actual free air per minute at thirty-five to sixty pounds. The nozzle pressure for timbers was about eight to fifteen pounds with fifty feet of hose. With one hundred feet of hose from two and one-half to five pounds increase was required. In guniting rock walls twenty to thirty pounds nozzle pressure was required for one hundred feet of hose. In building the buttresses and the bulkhead for the fire door, thirty-five to forty pounds air nozzle pressure was used, permitting a much greater feed and faster work. Toward the top of the bulkhead and on the finish, the nozzle pressure was cut down to fifteen pounds owing to the cramped working places, the lowest pressure used in the experimental work was eight pounds. The nozzle air pressure should be adequate to insure free flow through the hose and adhesion of the material.

Water in the compressed air causes clogging in the gun, causing much trouble and long delays. Where this trouble is experienced a water trap, or if none is available, a bleeder should be inserted into the air line.

Theoretically the greater number of coats the better the gunite. As each coat is allowed to set, its pores will be sealed by the following coat, and any cracks that may develop are thus covered and sealed. Three coats gave excellent results. For rock work the first coat should be as thin and dry as possible. We endeavored after some experimenting, to cover rock surfaces with a thin neat coat of cement permitting free rebound. This coat was not over one-eighth inch thick. After setting from twelve to twenty-four hours this coat was followed with three-sixteenths to one-fourth inch of gunite. After setting over night the third coat was put on about one-fourth inch thick, making a total thickness on rock surfaces from one-half to three-fourths inch. On timbers covered with reënforcing wire, the first coat should cover the reënforcement and therefore is often one-fourth to three-eighths inch thick. This coat is followed with at least two thin coats bringing the total thickness to one-half inch or more. In guniting, the man holding the nozzle should not permit the gunite to pile up. He should work the nozzle back and forth, spreading the gunite in thin layers or coats, as in painting.

(*Continued on page 194*)

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Importance of Daylight.

The unusual attention to gas and electric lighting in factories, mills and other work places during the past few years; the perfection of various lamps and auxiliaries, by means of which an improved quality and quantity of lighting effects are obtained; and the care which has been devoted to increasing the efficiency in various industrial apparatus—all go to emphasize the many advantages and economies that result from vital and adequate window space, as a means for daylight in the proper quantities, and in the right direction during those portions of the day when it is available.

Three Considerations.

Three important considerations of any lighting method are sufficiency, continuity and diffusion, with respect to the daylight illumination of interiors. Sufficiency demands adequate window area; continuity requires (a) large enough window area for use on reasonably dark days, (b) means for reducing the illumination when excessive, due to direct sunshine, and supplementing lighting equipment for use on particularly dark days, and especially towards the close of winter days, (c) diffusion demands interior decorations that are as light in color as practicable for ceilings and upper portions of walls, and of a dull or matt finish, in order that the light which enters the windows or that which is produced by lamps may not be absorbed and lost on the first object that it strikes; but that it may be returned by reflection and thus be used over and over again.

Diffusion also requires that the various sources of light, whether windows, skylights or lamps, be well distributed about the space to be lighted. Light colored surroundings as here suggested result in marked economy, but their main object is perhaps not so much economy as to obtain results that will be satisfactory to the human eye.

Requirements for natural lighting:

1. The light should be adequate for each employe.
2. The windows should be so spaced and located that daylight is fairly uniform over the working area.
3. The intensities of daylight should be such that artificial light will be required only during those portions of the day when it would naturally be considered necessary.
4. The windows should provide a quality of daylight which will avoid a glare, due to the sun's rays, and light from the sky shining directly into the eye, or where this does not prove to be the case at all parts of the day, window shades or other means should be available to make this end possible.

As will be noticed in the above recommendations, large windows and proper diffusion of daylight are urged, in order to meet the demands of daylight lighting.

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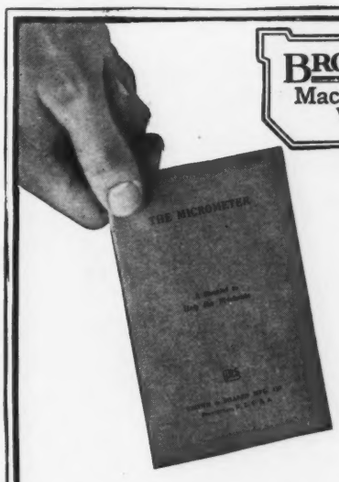

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GUNITE

(*Continued from page 192*)

Sand pockets should be avoided and cracks and pores filled up.

In striking the face only part of the mixture of wet sand-cement sticks to it. The coarser sand particles, especially in the first coat, are not cemented together, hence the rebound is often as much as twenty per cent of the first coat. During the second and third coats the amount is less as the sand finds a surface to cling to. Rebound is essential to make good gunite. It varies with the air pressure and the distance the nozzle is held from the face. Free rebound prevents sand pockets and insures tamping of the gunite by the coarser rebounding particles. The rebound contains very little cement, being more than ninety-five per cent sand. If kept clean this material may be used again after screening.

Underground, where the temperature is constant and the humidity relatively high, sprinkling may improve the quality of the gunite, but it is not absolutely necessary. Sprinkling was seldom done in these experiments. In surface work, sprinkling between coats and sprinkling on the finished job for several days prevents the development of superficial cracks through rapid drying.

To do efficient steady work, the gun crew should consist of four men, two at the gun and two at the nozzle. They should be ranked as chief and assistant gun men, and chief and assistant nozzle men. The assistants can alternate with the chiefs in keeping the gun loaded and operating, in moving the hose, keeping out the kinks, tracing trouble in the material hose, furnishing a light to the nozzle men, and in operating the nozzle. The nozzle operator's work is tedious and harassing, as he is being constantly pelted with rebound, is water soaked from running water and spray, his arms go back and forth lifting the heavy vibrating hose, his goggles are dimmed with the spray, his light when working underground is poor on account of the compressed air draft, he often works in restricted unventilated places, and the cement dust as a consequence is disagreeable. Unless he wears a respirator while working the nozzle, his throat and nose quickly become coated with cement. It is customary to pay the gun crew the highest prevailing mine wage, and in the writers' opinion it is deserved, especially by the chief gun runner and chief nozzle man. In addition to the gun crew, a mixing crew (generally two mixers) is necessary, also a delivery crew composed of one or more car men.

THE CLOTHES MOTH

(*Continued from page 172*)

to give a bath of the proper concentrations and constituents. This satisfactory reduction of the chemicals to the powder form, which may be brought into solution with the addition of water, so that articles may be easily treated in the home, will doubtless be enough inducement for every household, as well as the mammoth woolen and carpet mills, to aid in driving out this age-old pest.

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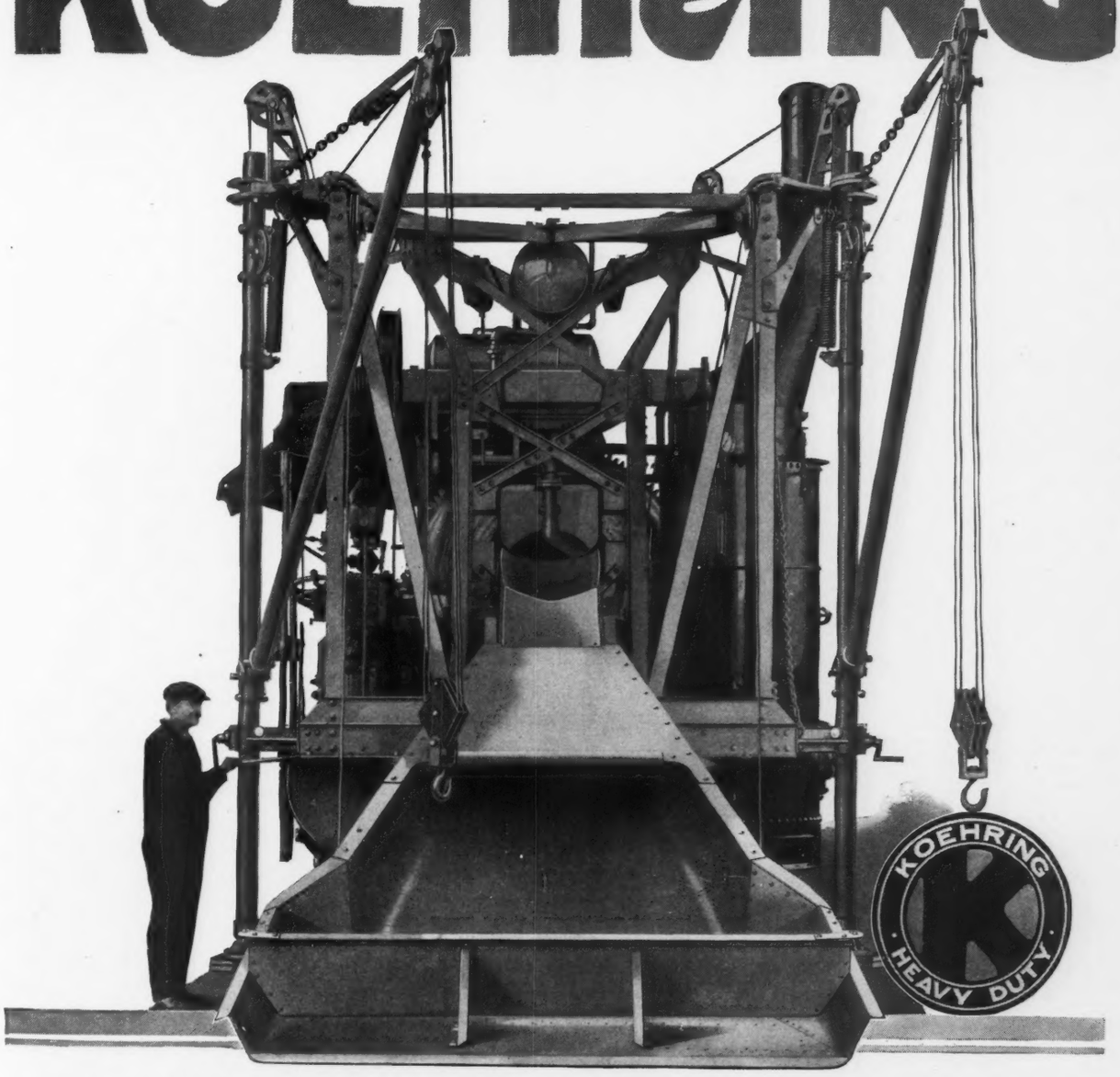

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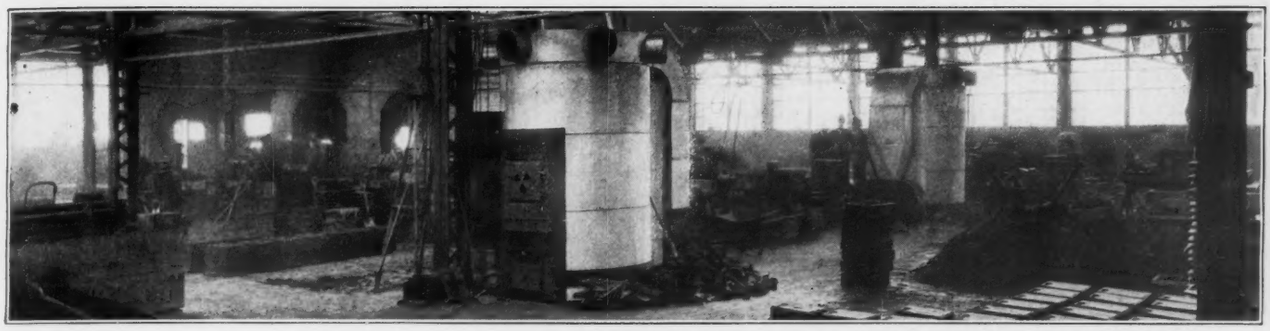

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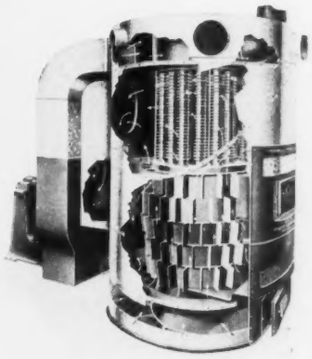
This great heater employs simple but radically different principles from other heaters. It forces warm air horizontally near the floor level in the direction needed. It puts warmth into every nook and corner.

Mechanical Hot-Blast Heater. Formerly manufactured by the Robert Gordon Co. Now built and sold exclusively by the B. F. Sturtevant Co., through their National Sales and Engineering Organization



1. Costs less to install than indirect heating systems and uses up to 50% less fuel.
2. Direct-fired. Burns economically either hard or soft coal, coke, oil, or gas.
3. Keeps the heat in circulation near the floor instead of allowing it to waste upward.
4. Ventilates. A Sturtevant Multivane Fan eliminates irritating fumes and steam. This is especially important in foundries.
5. Simple construction. Ordinary mechanic and helper can assemble it in a few hours.
6. Can be operated by anyone who can swing a shovel. Does not require the attention of a skilled engineer or boiler-man.
7. No steam or drip pipes to worry about. Nothing to freeze up.
8. Extended surface fins on the fire pot and the thin rings on the tubes provide a maximum heat-radiating surface.
9. Over-all efficiency is 81% by official test in the Laboratory of the Armour Institute of Technology. More than double that of any other type of heater.
10. Recommended for drying clay products, asbestos, magnesia, tobacco, cereals, vegetables, textiles, and all other products dried by warm air up to a temperature of 400°.

Shipment of these heaters can be made from stock if you act promptly. Call in one of our engineers and let him help you with your heating problems before the cold weather comes.

Send for Bulletin No. A306

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WILLIAM KONRAD ROENTGEN
1845-1923

Born in Lennep, Prussia. Educated at Zurich. Awarded the Rumford Medal of the Royal Society in 1896 jointly with Philip Lenard for discovery of X-rays. Won the Nobel Prize in physics in 1901.

"I did not think— I investigated"

One day in 1895, Roentgen noticed that a cardboard coated with fluorescent material glowed while a nearby Pluecker tube was in action. "What did you think?" an English scientist asked him. "I did not think; I investigated," was the reply.

Roentgen covered the tube with black paper. Still the cardboard glowed. He took photographs through a pine door and discovered on them a white band corresponding to the lead beading on the door. His investigation led to the discovery of X-rays.

Roentgen's rays have proved an inestimable boon to humanity. In the hands of doctor and surgeon they are saving life and reducing suffering. In the hands of the scientist they are yielding new knowledge—even of the arrangement and structure of atoms. The Research Laboratories of the General Electric Company have contributed greatly to these ends by developing more powerful and efficacious X-ray tubes.

The General Electric Company manufactures everything electric—from fans to powerful locomotives, from tiny lamps to mighty power plants. Its products are used around the world.

GENERAL ELECTRIC